

Annual Meeting, Atlantic City, N. J., Nov. 28—Dec. 2, 1932

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A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

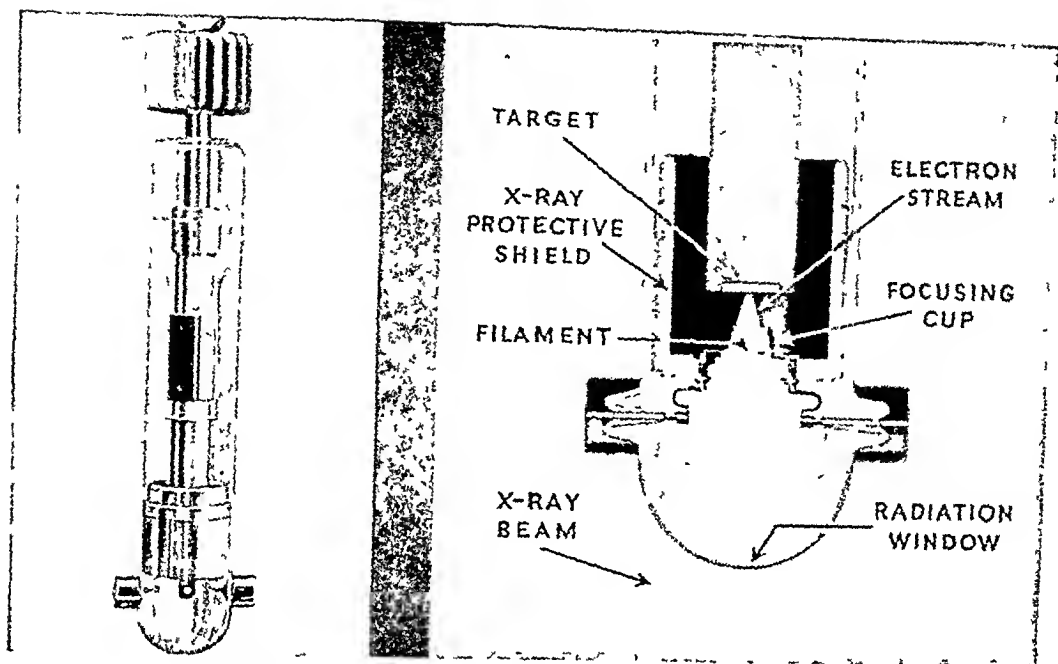
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THE TERMINAL ILEUM, APPENDIX, CECUM, AND ASCENDING COLON FROM THE STANDPOINT OF THE INTERNIST¹

By DONALD P. ABBOTT, M.D., CHICAGO

THE fluoroscope and films are but two methods of obtaining diagnostic evidence. The most efficacious use of the roentgen ray occurs when the information supplied by it is given its proper evaluation in the general evidence elicited by all methods. Personal discussion with the roentgenologist as a consultant may lead to a better understanding of the findings. There should be a spirit of co-operation, not a spirit of rivalry or antagonism. The internist should, if possible, be at the fluoroscopist's side, or furnish him otherwise with his ideas of the position and character of the pathology, just as he should be at the side of the surgeon when the abdomen is opened. Although, of course, both the surgeon and the fluoroscopist must make their routine examinations, their sessions with the patient must, of necessity, be short. The internist can save much time, expense, and trouble for the patient by directing attention to areas under suspicion. It is this close contact which I urge. The sense of sight and touch of the fluoroscopist and of the surgeon may fail to elicit pathology which has been proved to be present through days or weeks of study by the internist.

The appendix is probably the most important anatomic part, first, because it is the

most frequent serious cause of lower right quadrant distress (due to the urgency of early surgery); second, because of the much argued subject of chronic appendicitis, and, third, because of the frequent unnecessary removal of the appendix.

The very severe, fulminating case of appendicitis may be dismissed, because only rarely does it become necessary to use the roentgen rays. We must consider the subacute and chronic cases.

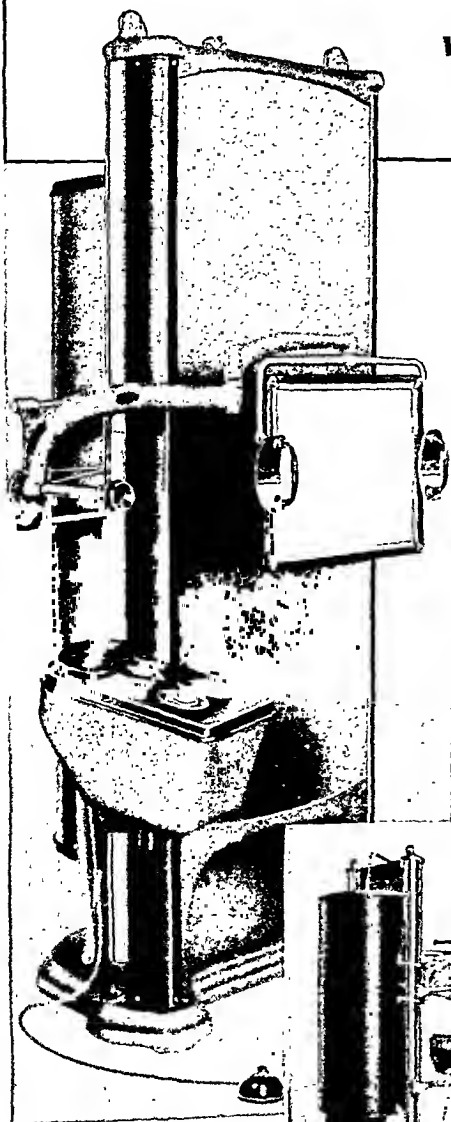
In both types, the symptom of greatest importance is rigidity, that is, involuntary muscle defense. Its presence in the right lower quadrant of the abdomen speaks for peritoneal irritation; in the absence of all other causes, it means an inflamed appendix. Having in mind the great length and varied positions which this organ may assume, it becomes necessary to exclude many other causes for pain and rigidity.

In the female, many ovarian (especially twisted pedicle of an ovarian cyst), tubal, broad ligament, and uterine conditions must be ruled out. In both sexes a long, inflamed appendix resting on the bladder or right ureter may suggest that the primary pathology is in the urinary system, even to the extent of showing blood microscopically in the urine. The appendix may extend to the left beyond the midline and, in a subacute attack, suggest an acute diverticulitis. Again

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

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still having pain. To be sure, it is better to remove nine normal appendices than to leave one which is diseased. In these cases the cecum, ascending, transverse, descending colon, or sigmoid are usually tender to deep palpation, and cramping may be seen fluoroscopically with, or without, pain. The sigmoid may extend to the right, causing pain in the right lower quadrant. Careful questioning reveals the use of abnormal irritants, such as cathartics, laxatives, enemas, indigestible oils, or it may be the use of foods injudiciously chosen for quality and quantity.

These patients give the history of abdominal distress associated with the desire to go to stool, softer stools than normal, alternating with harder ones. Flatulency and rumbling noises are noted. The cramping of the colon may be severe enough to cause nausea and vomiting, which, however, are promptly relieved by evacuating the colon. The barium enema may reproduce the nausea and pain. It is in these cases that I would stress the value of correcting the colon difficulty by diet, drugs, vaccine, psychiatry, etc., before formulating an opinion of the appendix. Get the bowel movements normal; stop gas production, and thus soothe the colon. If, in the course of perfectly normal stools, an attack of abdominal pain occurs, the analysis is simplified, for there is but one type of pain, the colon pain having subsided. If, however, the recurrence of pain is associated with softer stools than normal, an increase in gas production and expulsion, the pain relieved somewhat by passage of stool and flatus, we have fair proof that we are dealing with colitis. The removal of the appendix will not help this situation. Here, the tenderness may be present not only over the cecum and ascending colon, but also over other parts of the colon, especially that part of the descending colon which can be rolled against the wing of the left iliac bone.

Very rarely, in attacks of severe abdominal pain due to gallstones, appendicitis, or

disease of other abdominal organs, loose stools do occur, probably due to reflex psychic stimulation of the colon. The colon may thus falsely be held accountable for the primary cause of the pain. The distinguishing features of this diarrhea are its late onset after the onset of pain (the pain preceding the diarrhea by from two to eight hours or more), and the failure to gain relief from pain following defecation. These points suggest other cause than the colon. Pain, nausea, and vomiting attributable to colitis, if associated with diarrhea, are usually very soon followed by loose bowel movements. Relief from all these symptoms soon follows evacuation of the colon in most instances.

Thus, a small proportion of the chronic, repeatedly mildly inflamed appendices are diagnosed indirectly by the process of exclusion. Surgical intervention should be undertaken in the acute flare-up, since the patient is then more amenable to suggestion. However, in certain patients, it may be advisable to operate in the quiescent stage because of contemplated trips to regions in which emergency surgery is not available.

Let me emphasize, when *rigidity* is present with local tenderness, not a moment should be lost in time-consuming tests. Such an abdomen is surgical, when extrinsic causes are excluded.

Carcinoma of the ascending colon may reach considerable proportions before producing subjective symptoms. The bowel here is rather wide and its content fluid, thus signs of obstruction are late in appearing. The best means for early diagnosis are the fluoroscope, films, chemical examination of the stool for blood, and palpation.

Hypertrophic tuberculosis, hardly to be diagnosed except by the microscopist, is to be suspected in known cases of pulmonary tuberculosis with non-annular filling defects in the ascending colon. The same holds true for the ulcerative type.

While rare on the right, diverticulitis may

it may extend upward, so that the pain and rigidity are in the upper abdomen, suggesting gall-bladder, duodenal, or gastric disease. Its presence posterior to the ascending colon and cecum may mask the anterior findings and produce such pain in the back as to suggest a kidney disorder. And so there are a multiplicity of conditions which may be simulated by acute and subacute appendicitis and, likewise, a multiplicity of other conditions which may simulate this disease.

Rigidity and local tenderness are the most important findings. They alone, when limited to the right lower quadrant, make surgery the safest course to pursue. Fortunately, however, there are usually associated symptoms, such as slight rise in temperature, rising leukocyte counts, slight nausea, vomiting, right psoas muscle spasm, pain on jarring, and so forth. In children presenting acute infections or pneumonia with diaphragmatic pleurisy, rigidity may be present and is to be differentiated. A film of the lung may be helpful. In the acute and subacute and chronic attacks, the roentgen ray aids best by assisting in the exclusion of other causes.

The chronic type of appendicitis is probably the most confusing to the internist, surgeon, and roentgenologist, especially so in the presence of chronic colitis. However, patients with the chronic type have, in the course of the disease, *attacks* of varying degrees of severity associated with localized pain and tenderness which, with the fluoroscope, may be definitely attributed to the appendix, if the latter can be filled. When it cannot be filled, a tender spot outside the area of the cecum may be attributed to the appendix, if all other causes are excluded. Such mild attacks can better be attributed to an inflamed appendix, if the pain is aggravated by those factors which mechanically irritate an inflamed peritoneal surface, such as jarring, bending, coughing, and contraction of the iliopsoas muscle. The pain may

extend into the thigh. When the distress continues for from 48 to 72 hours, it is more suggestive of an inflamed appendix. The finding of a slight rise in temperature and gradually increasing leukocyte count, with rigidity, would complete the diagnosis. It is to be remembered that occasionally a long appendix, extending low into the true pelvis, when it is mildly inflamed, may produce atypical symptoms, which, for years, are inadequately explained. Yet, during an attack, a rectal digital examination may reveal a constant point of marked local tenderness. When it is found, a film should be made, for a fecalith with calcium content may be revealed.

In these chronic cases, the mildness of the symptoms permits a more extensive roentgenologic study. Especially when the patient is seen between attacks the roentgen ray is of great value, aiding markedly in the process of elimination, until no anatomic part remains to be accused except the appendix. Here the history of attacks, with apparent freedom from distress between, is suggestive of appendiceal disease. It is my custom to make a plain film of the genitourinary tract, examine the stomach fluoroscopically, and follow the barium through to the ascending colon, especially observing the terminal loops of the ileum, ileocecal valve, cecum, and appendix. This is followed by a colon fluoroscopy from below. The finding of a kinked, tortuous, beaded, fixed appendix, with tenderness localized on rolling only the appendix, would fit in with our suspicion that it is pathologic. The finding of a calcified fecalith in the appendix would support this. A kinked and tortuous terminal ileum would speak for adhesions.

The picture is further complicated, and the difficulties of diagnosis multiplied, if these mild attacks occur in individuals suffering with chronic colitis, having some abdominal distress daily due to a crampy colon. This is the individual who so often comes to the internist with the appendix removed.



Fig. 2-A.

Fig. 2-B.

were no other findings. Examination revealed a small nodular mass about the size of a hazel-nut in the right lower quadrant in the region of the ileocecal valve. There was slight tenderness here at times. Definite stiffening of the bowel could be felt to come and go under the fingers, yet distress disappeared upon stopping all fermentation and obtaining normal stools. No gross blood was seen.

Colon fluoroscopy showed marked evidence of spasm in the descending colon, also an obstruction which remained as a narrowed region just above the ileocecal valve. Barium finally entered the cecum, filling it and the terminal ileum. The mass palpated corresponded to the narrow region in the ascending colon. This mass, which was resected by Dr. Dean Lewis in November, 1924, was found to be an annular carcinoma of the cecum just above the ileocecal valve. The patient is alive, with no recurrence at this date.

Case 2 (Figs. 2-A and 2-B). H. M. L., white, male, aged 59 years, a manufacturer,

was seen in 1925, when the following diagnosis was made: colitis, maxillary sinusitis, and slight chronic splenic tumor due to malaria.

The patient returned Jan. 12, 1927, complaining of a mass in the right lower quadrant of the abdomen, gross blood in the stools, and bloodshot eyes. The mass, which was located in the cecal region, was moderately firm and could be moved up and down for a distance of two or three inches. It elevated the abdominal wall slightly and was considered as a possible pedunculated polypus because of its mobility.

The blood count showed 9,420,000 red blood cells, 16,500 white blood cells, and 110 per cent hemoglobin. The differential count showed 90 per cent polymorphonuclear neutrophils, 5 per cent small mononuclears, 4 per cent large mononuclears, and 1 per cent transitional cells.

The spleen had enlarged from its former position, above the rib margin, to extend two fingers' breadth below. Colon fluoroscopy revealed a rounded, somewhat mottled



Fig. 1. An annular carcinoma of the cecum just above the ileocecal valve.

occur in a sigmoid lying to the right or in the the ascending colon. A previous knowledge of the presence of such diverticula may justify a suspicion of the diagnosis of diverticulitis, but it would be safer to operate. Polypi in the ascending colon or in the sigmoid, lying in the right lower abdomen, may be the cause of right lower quadrant pain.

The terminal ileum is rarely the seat of chronic disease. The more frequent clinical conditions are adhesions to the pelvic organs (in the female) and the appendiceal region, or anterior abdominal wall scars, often with mild, repeated, or severe acute attacks of obstruction. Rarely, papillomas occur in the terminal portion of the ileum. Also Meckel's diverticulum must be sought. Primary tumors in the ileocecal valve or adjacent regions may cause the same clinical

picture. Here the careful analysis of the distress picture is most fruitful. It reveals a series of abdominal pains, each series made up of one or more cycles, each cycle characterized by two or more mild or severe cramp-like pains coming at intervals of a few minutes, culminating perhaps in a gurgling, squirting sound, only to be repeated a few minutes or hours later. These attacks may be months or years apart, daily or hourly, severe or mild, depending upon the cause and degree of obstruction. When they are seen early in an attack, there may be no abdominal distention, no visible or palpable peristalsis, yet a film of the abdomen may reveal a distended loop of ileum in the pelvis or elsewhere, adding further weight to the suspicion of obstruction. When justifiable, the obstructive symptoms being of a very mild character, and the colon having been excluded as the site of the lesion, barium may be followed through to the cecum. A thicker terminal ileum shadow (*i.e.*, denser than usual) with loss of valvulae conniventes markings, and hyperperistalsis, suggest obstruction at the ileocecal valve. I would advise the careful scrutiny of the terminal ileum and this valve in fluoroscopy of the colon, and more follow-through observations in cases presenting obscure signs in the right lower quadrant.

CASE REPORTS

Case 1 (Fig. 1). C. B., white, male, aged 40 years, druggist, came to me in August, 1924, complaining of cramping abdominal pain and diarrhea which had persisted for two months, fullness, and pressure, especially in the right upper and lower quadrants, and the loss of 10 pounds in weight. He had two or three bowel movements a day—mushy, gruelly, or watery—with much spattering of stool and excessive quantity of gas, followed by relief from pain. He attributed the onset to an attack of influenza six months previously. Except for atrophic rhinitis and slight bronchial asthma, there



Fig. 5-A.



Fig. 5-B.

colon revealed nothing, but a film showed the sigmoid to extend to the right almost to the cecum. In one portion of the sigmoid, a slightly decreased density of the opaque medium was noted. A polypus was suspected and re-examination advised. Repeated fluoroscopies of the colon indicated a definite filling defect limited to this same region. The width of the lumen of the bowel was not affected. Diagnosis of a bleeding, pedunculated polypus was made, and verified at operation by Dr. Dean Lewis.

Case 4 (Fig. 4). This case illustrates the value of films taken before the introduction of a contrast medium in abdominal pain of obstructive character.

P. McM., white, female, aged 28 years, married, had been under my care for months because of complaint of a very irritable colon. On Jan. 1, 1929, she complained of an attack of pain in the *left upper quadrant*, quite different from any that she had had before, which was present for one hour

and was associated with nausea. A few hours later the character of the pain spoke for intestinal obstruction. She entered the hospital, where a film of the abdomen was made. This showed a distended loop of small bowel above the navel and one in the pelvis. The abdomen, which was not distended, was quite comfortable between the attacks of pain. The attacks becoming more and more marked, with nausea and vomiting, the patient finally consented to an operation.

The terminal portion of the ileum was found adherent in the pelvis to the right tube. There was no acute inflammatory process. A lateral anastomosis was made by Dr. Edwin Miller, with complete recovery. It is interesting to note that the pain was first felt in the left upper quadrant.

Case 5 (Figs. 5-A, 5-B, and 5-C). W. C. P., white, male, aged 51 years, a judge, came to me on Nov. 21, 1926, complaining of diarrhea of three weeks' dura-



Fig 3 Case of right lower quadrant pain.



Fig 4 The terminal portion of the ileum was adherent in the pelvis to the right tube: there was no acute inflammatory process

filling defect within the lumen of the cecum, elicited only by pressure. The mass felt corresponded to the filling defect and could be pushed up in the ascending colon a distance of from 2 to 3 inches. The margins of the cecum and ascending colon were normal, as were the ileocecal valve and terminal ileum.

We diagnosed polycythemia vera (erythremia), a pedunculated polypus of the ascending colon, with torsion, gangrene, and sloughing, and, in addition, Buerger's disease of the right lower extremity, the findings of which were typical.

There was no operation. This patient has been observed frequently, and no evidence of his polypus remains at the present time. The polycythemia is adequately taken care of by a roentgenologist, and the symptoms of Buerger's disease have disappeared.

Case 3 (Fig 3). This case illustrates

how a right lower quadrant pain may be due to the sigmoid.

E. M. L., white, male, aged 56 years, a teacher, came to me on June 4, 1924, complaining of a "grating" pain of eight years' duration in the right lower quadrant, and diarrheal stools intermittently for 17 years. The grating sensation in the right side was not relieved by the passage of stool or gas, but might be relieved by a five-minute rest, or by a hot-water bag. It was not a real pain, but a discomfort. At intervals, blood had been seen in the stools, which were always soft, for a period of about nine years. The rest of the history was negative. Passage of normal stools did not relieve the grating pain.

The first fluoroscopic examination of the

which lasted for five or six hours, was relieved by morphine. One week later diarrhea began, with two or three watery stools daily. Red blood was seen in two stools. There was much flatulency, and the distress shifted from the ascending to the transverse and descending colon regions. Desire to go to stool was usually associated with abdominal pain. Except for tuberculous glands at eight years of age and tuberculosis of the left tibia, his history was negative. One brother had pulmonary tuberculosis and two children had tuberculosis.

The analysis of his abdominal pain showed that it was partly due to the colon. In the lower abdomen there was, in addition, a rhythmic type of pain, very mild in character, which suggested a low-grade obstruction, probably in the lower ileum. He was very fat so that palpation was difficult. The Wassermann test and blood counts were negative. A genito-urinary film showed prostatic calculi, and fluoroscopy of the colon showed marked spasm throughout. In addition, there was a constant marked incisura on the lateral aspect of the ascending colon, opposite the region of the ileocecal valve and its frenulum, a decreased density in this region, and a peculiar contracted condition of the cecum.

Next, a follow-through fluoroscopic and film examination of the ileum was made. This revealed stasis in the terminal ileum, evidenced mainly by a denser column of barium than usual (not widened), loss of the valvulae conniventes (plicae circulares), and a marked hyperperistalsis. Based upon all this evidence, a diagnosis was made of intestinal obstruction by a tumor in the region of the ileocecal valve. Dr. A. D. Bevan removed the terminal ileum, cecum, and a portion of the ascending colon. Upon opening this, a pedunculated lipoma was found attached to the last inch of the ileum. It had herniated through the ileocecal valve, and become twisted and semigangrenous,



Fig. 6 Case in which postmortem revealed an annular adenocarcinoma of the terminal inch of the ileum and ileocecal valve.

with some sloughing, which accounted for the red blood seen in the stool.

Case 6 (Fig. 6). Mrs. P. W., white, aged 83 years, was bed-ridden, due to a partial stroke, when she was first seen in December, 1929. In addition to heart block, the patient had had intermittent attacks of pain in the abdomen for six months, which, during the last two months, had occurred daily. Although the pain was usually in the right side below the navel, it might start in the left side and proceed to the right. The patient thought the pain was relieved by the passage of flatus, of which there was a great quantity. Bowel movements always had been loose. The abdomen had been gradually becoming larger.

Examination of the abdomen revealed very definite peristaltic stiffening of what appeared to be loops of the small bowel. The diagnosis was small bowel obstruction, probably due to carcinoma in the region of the ileocecal valve.

Colon fluoroscopy was negative. No barium entered the ileum. Because the obstruction was slight and was in a region in which the bowel content is watery, it was considered safe to give a small amount of barium by mouth. The fluoroscope showed a distinct constant narrowing of the last

tion, and distress shifting throughout the abdomen. Seven years previous to the present examination, he had had a few subjective symptoms of what was thought to be ureteral colic, but examination of the urinary

tract at that time was negative. Three weeks before I saw him, his pain again started in the right lumbar region, radiating to the lower abdomen midway between the symphysis and the umbilicus. This pain,

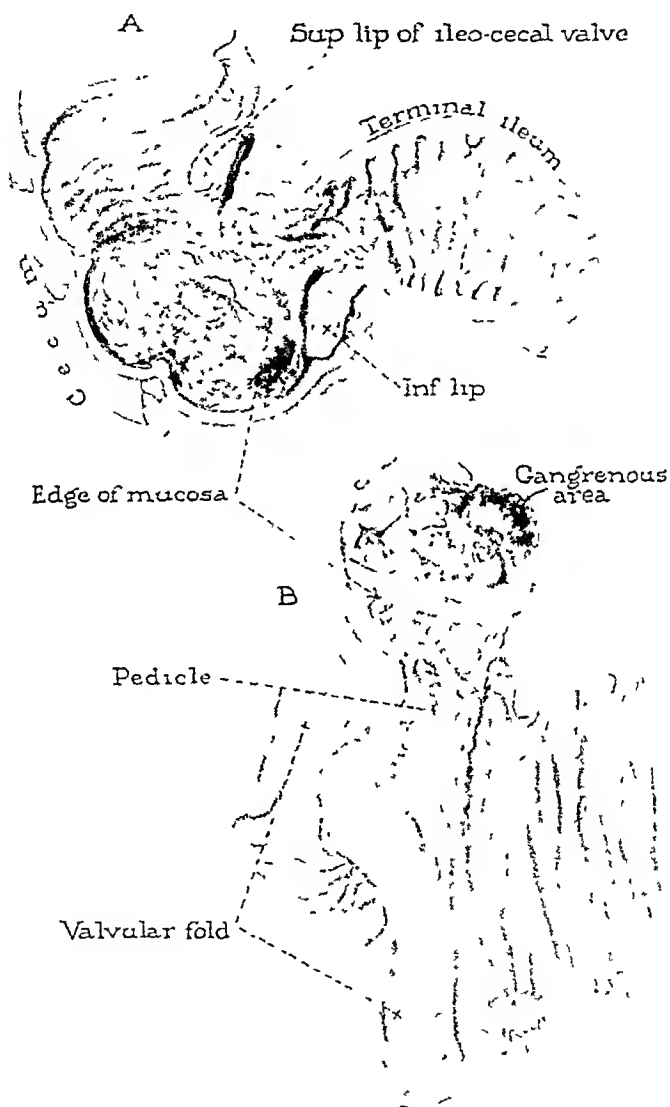


Fig 5-C. A pedunculated lipoma, attached to the last inch of the ileum, had herniated through the ileocecal valve and become twisted and semigangrenous, with some sloughing

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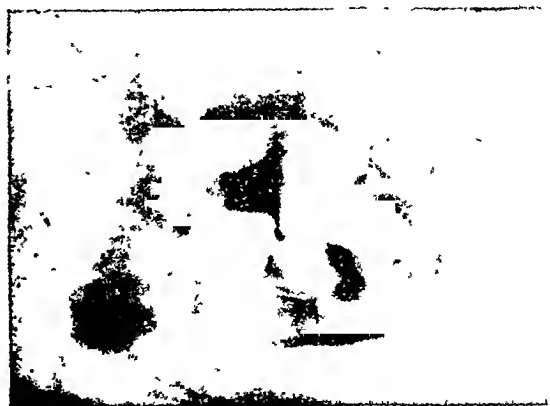


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Colon fluoroscopy was negative. No barium entered the ileum. Because the obstruction was slight and was in a region in which the bowel content is watery, it was considered safe to give a small amount of barium by mouth. The fluoroscope showed a distinct constant narrowing of the last

inch of the ileum, with loss of the typical arrow-shaped ileocecal valve region shadow. In addition, the last portion of ileum showed a denser column of barium than normal, loss of the normal plicae circulares markings, and severe hyperperistalsis. Operation was refused. Postmortem revealed an annular adenocarcinoma of the terminal inch of the ileum and ileocecal valve.

CONCLUSIONS

I would stress the importance of the internist's co-operating with the roentgenologist as a consultant, not only on paper but by personal visits to the department in the hospital or clinic group. The experience will be mutually beneficial, as well as profitable from the patient's standpoint.

The patient with definite evidence of colitis, but questionable evidence of appendicitis, should have the former condition cleared

up. During this treatment, close watch can be kept for any attacks of appendicitis.

Patients having abdominal pain of obscure origin should have films made of the abdomen prior to the introduction of a contrast medium.

The Graham-Cole gall-bladder dye test is now so easily given orally, and so often reveals pathology which has caused obscure or non-subjective symptoms, that it has become almost routine in my service for patients who have suffered attacks of abdominal distress or who have had vague symptoms referable to the stomach or bowel.

It is also suggested that more small bowel fluoroscopies be done in cases showing negative colon examinations but presenting lower abdominal pain which is not otherwise explained. The internist is advised to study the character of the pain present in each attack, in an endeavor to elicit that type which is characteristic of intestinal obstruction.

A Powerful X-ray Tube.—At two great electrical laboratories in America, the California Institute of Technology, in Pasadena, California, and the General Electric Company, at Schenectady, New York, 1,000,000-volt X-ray tubes are soon to be available for therapeutic use. Dr. C. C. Lauritsen, of the California Institute of Technology, estimated that the 550,000-volt two-kilowatt X-ray tube now temporarily diverted from physical research to experimental treatment of cancer cases is equivalent to at least 100 grams of radium,

which, if they could be obtained, would be worth six million dollars. In a new radiation laboratory Dr. Lauritsen and his associates are now building an X-ray tube to operate at 1,000,000 volts. This will produce hard, penetrating rays that all the radium in the world could not produce, and the physicians working with the physicists will be able to direct the output of this most powerful tube at a single case of cancer if research during the next few years shows that to be desirable.—*Science Service.*

PROTECTION IN ROENTGEN THERAPY¹

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THE question of protection in roentgen therapy is so important that, even though the subject has been well covered by such men as Pancoast (1), Wood (2), and Taylor (3) in this country, and Glocker (5), Bouwers and van der Tuuk (6), and Herrmann and Jaeger (4) in Europe, it seems worth while at this time to re-emphasize some of the salient points. The subject has been so adequately covered by these authors that I shall not emphasize location of the laboratory, electrical protection, or even primary radiation protection as built into the department. The Advisory Committee on X-ray and Radium Protection, which has issued a long series of very valuable recommendations, gives a table of lead protective equivalents for voltages from 75 to 600 kilovolts. Even though these recommendations are followed as closely as possible, tests should be made to ascertain if protection is being afforded. This can be done by the operators carrying dental films for several weeks at a time and by having adequate blood examinations made every few months as an additional check-up.

In the treatment of malignant disease by X-rays, more and more radiation is being applied as we realize that only with sufficient dosage can we successfully combat this condition. It, therefore, becomes increasingly important that the patient be protected from all stray radiation and that only the area which it is desired to treat actually receive the ray. In the use of voltages up to 140 K.V., it is quite common to employ the open glass bowl as a shield against stray radiation. However, there are so many places and so many directions from which

the rays can leave the tube that one must be exceedingly careful to give the patient sufficient protection.

For example, in tilting the tube to accommodate an exposure about the head or neck, one can easily place the tube stem in such a position that rays will escape from the bowl through the notch which receives the tube stem. These escaping rays, which are necessarily unfiltered, may cause, in treatments of considerable duration, undesirable and exceedingly troublesome roentgen irritations. The result may be epilation or even superficial ulceration. One way to avoid these consequences is to cover the patient entirely with lead rubber or to have an adjustable, lead-covered frame which can be placed entirely over the patient, except for the field which is being treated. It is not pleasant nor always desirable, however, to cover the patient's head—one always runs the risk of giving undesired radiation in this region. Careful positioning of the tube stem will in part obviate this danger, but the possibility of damage is always present. Another way to help is to cut out flaps of lead rubber and hang them on the tube stems so that they cover the notches in the glass bowl, thus relieving oneself of considerable concern. But the best way to eliminate all possibility of serious damage from stray radiation from an open-bowl-enclosed tube is either to eliminate the bowl and enclose the tube in a lead container or to confine oneself to treatment of conditions requiring relatively small amounts of radiation.

In the use of voltages higher than 140 K.V., it is advisable to have the tube entirely enclosed in lead, except for the opening through which the primary beam emerges and is directed upon the patient.

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

Adjustable or non-adjustable lead drums, self-protective tubes, the treatment couch, or the "slanting wall" can be used to secure electrical protection, except in the case of the open self-protective tube. By the use of such apparatus, one can confine one's vigilance to the placing of proper filter and the control of the other factors. The use of pressure cones, such as those devised by Holfelder, Wintz, and others, relieves one of the uncertainty of target-skin distance and field size; thus these cones are a protection both to patient and roentgenologist.

Since a large proportion of roentgen injuries are caused by omission of the proper filter, every precaution possible should be taken to prevent such a disaster. The use of colored tapes on various thicknesses of filter, each color representing a definite filter material and thickness, is of great value. One should have beside the window through which the patient is observed a list of the filters and their corresponding colors. Relays which prevent the closing of the X-ray switch if the filter is not in place are also of value, and one may have electric bulbs which light when the filter is in place and indicate which filter is in position. For use in the open bowl, a combination of colored tags and a double hook, which is attached to a minimum filter and through which connection is made between the anode and its connecting wire, has been found to be of very great assistance. With this, the current will not pass through the tube unless a hook is available—and a hook is not available unless a filter is in hand. This double hook was suggested by Holzknecht. If the technic is uniform, the filter can be screwed or locked in place.

In addition to all these visual, electrical, or mechanical checks on filter position, one must use eternal vigilance, since any one of them may possibly fail. When the factors for a particular treatment are determined and all settings made, a complete and accurate record should be made and signed by

two responsible persons, one of whom must be a physician. Under no conditions should the checking of filter, distance, field, and time become a matter of mere routine, for, if it does, the value of the procedure is at once lost. When a long series of treatments is being given, it is well to tell the patient what color his or her filter carries.

For the laboratories which can afford it, an X-ray intensity indicator, or a dosimeter, is advisable as an additional filter control.

I should like to emphasize at this time the importance of accuracy of roentgen dosage as a protection, not only to the patient, but to the roentgenologist as well. With well calibrated apparatus, recalibration of which should be done at least once a month or whenever a tube is changed or rectification altered, one can much more easily ward off any possibility of suit in case a patient becomes litigious.

Whenever possible, uniform technic should be used, the variable factors being kept down to a minimum so that considerable automatic protection may be afforded. On any particular machine, kilovoltage and milliamperage should remain constant; distance and field can automatically be cared for by the use of proper cones. That leaves only dosage, preferably in r—controlled by time factor and filter—to be determined.

Since the utilization of the roentgen ray in the treatment of malignancies is, of necessity, being carried more and more to the point of definite skin reaction, it is wise to face this fact and to caution the patient beforehand what may be expected. Properly controlled skin reaction—and here accurate calibration is of great value—need cause the roentgenologist no alarm since there is usually *restitutio ad integrum*. If sequelæ ensue, they are of minor importance compared with the original condition for which the patient was treated. If a patient is approached properly, there is usually no difficulty in explaining the situation, especially if the approach is made before treat-

ment is begun. At this time, also, the patient should be given instruction in the care of all irradiated areas so that they will not become unduly irritated. The use of the word "burn" should be avoided entirely since it has come to have in the lay mind, as well as in that of a considerable part of the medical profession, an ominous and sinister meaning when coupled with either X-rays or radium. Possible changes in the fertility of women in the child-bearing age should also be discussed with the patient or a responsible member of her family.

SUMMARY

In considering protection, several points are emphasized: (1) methods of filter control, (2) treatment factor records, (3) accu-

rate calibration of apparatus, and (4) complete understanding with the patient of superficial reactions and other changes due to the irradiation.

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Single Cosmic Rays Detected by New Instrument.—Cosmic rays plunging to earth from the depths of outer space are recorded unambiguously in a 15-foot iron tube detector. Dr. W. F. G. Swann and Dr. J. C. Street, of the Bartol Research Foundation of the Franklin Institute, stated in April before the American Physical Society.

About four times each hour the cosmic rays travel the whole length of the nitrogen-filled tube and cause a spurt of electrical current that Dr. Swann and Dr. Street find is twenty times that caused by the passage of an alpha particle or heart of a helium atom. They have thus obtained direct evidence that the cosmic radiation occurs in individual packets and that

it might be considered a series of bullets with high energy.

In their measurements of the cosmic rays with the 15-foot tube, Dr. Swann and Dr. Street found evidence of radiations that are even more electrically exciting than the cosmic rays. Spurts of ionization current larger than those caused by the cosmic rays were consistently recorded. They seem to be caused by something that happens inside the tube. Dr. Swann suggested that these unknown radiations may be the same as the rays discovered by Prof. G. Hoffmann, and attributed by him to the breaking down of the hearts of atoms in the wall of the iron tube.—*Science Service*.

THE RETICULO-ENDOTHELIAL SYSTEM AND ITS RELATION TO THE ROENTGEN STUDY OF THE LIVER AND SPLEEN AFTER THE INTRAVENOUS ADMINISTRATION OF THORIUM DIOXIDE SOLUTION¹

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THE recognition of pathologic changes in the liver and spleen has always been a stumbling block to the roentgenologist. With the aid of pneumoperitoneum, and even without it, to a limited degree, it is possible to recognize alterations in size and position, but not until recently has it been possible to show even gross alterations in structure.

Since the discovery of the roentgenographic gall-bladder function test by Graham and Cole, in 1923, numerous roentgenologists have noted an increased density of the liver a few hours after administration of the phenolphthalein salt. This phenomenon enabled Einhorn and Stewart to observe alterations of structure, due to metastatic carcinoma and cysts of the liver, which they reported in 1927. Although this test has contributed much to the diagnosis of gall-bladder disease, its contribution to the roentgen diagnosis of diseases of the liver has been practically nil.

In 1928, Radt, in his clinic at the University of Berlin, began work on the theoretic assumption that a colloidal material of sufficient atomic weight, when injected intravenously, might be taken up by the reticulo-endothelial cells in sufficient quantity to visualize the liver and spleen roentgenographically. They first used in animal experimentation a thorium dioxide preparation called tordiol. But tordiol is not a stable colloid and, for this reason, the danger of capillary embolus formation made it unfit for use in human beings.

Oka, a Japanese, investigated the proper-

ties of tordiol and its effect on animal tissues. He was unable to find any evidence of the substance in the excretions and proved that it was deposited in the cells of the liver and spleen.

Because of the possible danger from tordiol, Oka, and later Radt, used a somewhat similar preparation called thorium dioxide sol. After many months of experimentation, this was thought to be a perfectly safe medium. Animals that had been injected two years previously did not differ from others not injected, despite the fact that the substance remains stored in the tissues. The blood picture showed a slight temporary leukocytosis and a temporary decrease in hemoglobin content. Chemical examination of the blood showed no abnormality. Similar changes were found in human beings subjected to the test.

Twenty patients injected by Radt and six by Oka were observed over a period of months. No ill effects were noted except that, in occasional cases, several hours after injection, there appeared a slight transitory discomfort, slight tension of the limbs, chills, and slight rise in temperature.

They were able by this method to visualize clearly the liver and spleen and to show some of the structure of these organs. The size and contour of the liver and spleen were plainly visible. In several instances, such pathologic conditions as metastatic carcinoma and cirrhosis of the liver were correctly diagnosed.

Radt feels that this procedure is a valuable adjunct in the diagnosis of diseases of the liver and spleen, pointing out the possibility of diagnosing such abnormalities as

¹Read by Thomas A. Groover, M.D., before the Radiological Society of North America, at the Seventeenth Annual Meeting at St. Louis, Nov. 30-Dec. 4, 1931.

echinococcus cysts, liver abscess, hemangioma, and other disease of these organs which might grossly alter their structure.

At the meeting of the American Roentgen Ray Society in September, 1931, Einhorn, Stewart, and Illick reported eight cases in which they had given thorium dioxide sol. Because they reported two rather severe reactions several hours following injection, they felt that a medium which is retained within the tissues may be a source of future damage.

References to the work of Radt and Oka are to be found in recent foreign literature, indicating that it is arousing considerable interest.

In order that we may attempt to judge the value of this test, appraise its possibilities, anticipate possible dangers, and intelligently use it, it is necessary that we have some knowledge of the chemical and physiologic properties of the substance used in making it, and of the anatomy, physiology, and pathology of the reticulo-endothelial cells.

It is not within the scope of this paper to discuss in detail the reticulo-endothelial system. We shall merely outline the known structure, function, and abnormalities of the cells which make up what may be considered an organ of the body—an organ as diffusely scattered throughout the body as the lymphoid tissue.

Aschoff distinguishes two groups of cells in this system, one stationary and the other free. The stationary group includes the reticulum cells of the splenic pulp, lymphatic tissue, and bone marrow, adrenal cortex, hypophysis, sinuses of the lymph nodes, and spleen. The wandering elements include the tissue and blood histocytes and the splenocytes. Especially important parts of the system, and the ones particularly related to our subject, are the so-called endothelial cells which form the incomplete lining of the sinusoids of the liver and spleen. In the liver, the cells, which are known as the

Kupffer, or stellate, cells, lie in direct contact with the blood on the one hand and the liver cells on the other. In the spleen, the cells in question are also to be found lining the sinusoids and forming in addition the branched reticulum cells of the splenic pulp.

On the basis of the difference between the reaction to dyes of the endothelium of the splenic sinuses and that of the reticular cells of the pulp, some recent observers conclude that there is no such thing as "reticulo-endothelium," at least in the spleen. But these newer studies do not invalidate the conception of the functional unity of the reticulo-endothelial system. The term "hemolytopoietic," introduced by Krumbhaar, has merit in that it indicates the organs subserving hematopoietic and hemolytic functions, *i.e.*, the bone marrow, spleen, lymph nodes, and liver. However, we know that there exists in lymphoid tissue, liver, bone marrow, connective tissue, and in the blood stream a group of cells having common morphology, perhaps a common or closely related origin, and a common function. For the sake of simplicity it seems that we may speak of these cells collectively under one head and call them the reticulo-endothelial system, even though it may be intimately connected with other systems. The relation to other systems may possibly be analogous to the relation of the nervous system to the gastro-intestinal and urinary systems.

The generally accepted functions of the reticulo-endothelial system may be summarized as follows:

1. *Phagocytosis*.—It is a well known fact that the reticulo-endothelial cells are able to store colloids and other foreign materials within their cytoplasm. This function forms the basis of the work under consideration.

2. *Hemocytopoiesis*.—The origin of the blood cells is still a debatable question. The findings of Sabin and her co-workers, how-



Fig. 1. Shows a definitely enlarged spleen (a) and the liver (b), which is probably also enlarged. The patient, who is 18 months of age, has generalized tuberculous lymphadenitis with infiltration in the upper lobe of the left lung.

ever, indicate that the red cells arise from the endothelium of bone marrow, and the white cells—including the polymorphonuclears, the monocytes, and the lymphocytes—come from a primitive reticular cell.

3 *Destruction of Senescent Blood Cells.*—This function is carried on particularly by the cells of the splenic pulp.

4 *Splitting Off of Bile Pigment from Hemoglobin.*—The cells of the splenic pulp remove the iron from the hemoglobin molecule and elaborate an iron-free substance closely allied to bilirubin. This pigment is then discharged into the blood, possibly by disintegration of the pigment-containing cells after they have entered the blood stream. After extirpation of the spleen, these functions are carried on vicariously by other representatives of the reticulo-endo-

thelial system, such as the Kupffer cells of the liver or the reticulum cells of the lymph nodes and bone marrow. It has been shown experimentally that, under normal conditions, approximately 50 per cent of the bile pigment is formed in the cells of the liver and the remainder in the reticulo-endothelial cells elsewhere. The liver, therefore, apparently is no more active in the production of bile pigment, considering its size and weight, than the other cells comprising the system. Rich, by demonstrating the formation of urobilin from hemoglobin in pure cultures of cells of the reticulo-endothelial system, has conclusively proven that the liver is not necessary for the production of bile pigments.

5 *Storage of Iron Pigment.*—The exact function in the storage of iron pigment is not clear. In such conditions as pernicious anemia, the reticulo-endothelial cells are found to be filled with iron-containing pigment.

6 *Apparent Inhibition of the Growth of Tumor Cells.*—The work of Brüda and others indicates that the reticulo-endothelial cells may elaborate a substance which has an inhibiting effect on certain types of tumor cells.

7 *Participation in the Formation of the Characteristic Lesions of Certain Specific Infections.*—It is felt by many investigators that the cells of this system make up the characteristic lesions of tuberculosis, typhoid fever, leprosy, and rheumatic fever. It is thought that they are particularly prominent in the body reactions to kala-azar, trypanosomiasis, typhus fever, Oroya fever, Rocky Mountain spotted fever, trench fever, and measles.

8 *Participation in the Immune Reactions of the Body to Infection.*—This well known function is too broad a subject for discussion in this paper.

Of particular interest to us in our work is the effect on the organism as a whole of



Fig. 2. Shows Riedel lobe of the liver (a) and an enlarged spleen (b), due to leukemia. Note the distinctness of the renal shadows (c), which may be due to storage of some of the medium in these organs.



Fig. 3. Shows defect in liver shadow due to hemangioma. Note that it does not have the annular characteristics of carcinoma as shown in Figure 6. It would have been desirable in this case to have placed the film transversely as recommended in the section on technic.



Fig. 4. Shows an enlarged liver—cause undetermined. Note the blood vessel markings in the liver, indicated by arrows.

sudden filling with foreign material of the cells of this system. While the effect of physical blockade of the reticulo-endothelial system has been studied by many investigators, there has been no uniformity in the results obtained. On the one hand, such men as Jungeblut and Berlot, Gay, Clark, and others maintain that the blockade of the reticulo-endothelial system inhibits antibody production. On the other hand, such investigators as Rosenthal, Moses, Petzel, Standeneth, and others hold that there may be even an increased antibody production after blockade of the system.

In this connection the results of experiments by Howell and Beverley should be stressed. These investigators have been able to show that the reticulo-endothelial cells—at least those of the bone marrow, spleen, liver, and lymph nodes—are able to take up foreign material in practically any quantity. This observation was made two years previous to their report by Brickner. Suppression of antibody response to typhoid vaccine could not be accomplished in rabbits and rats after repeated injections of one or

of multiple non-protein foreign materials, although these materials were taken up in large quantities by the reticulo-endothelial cells. However, the sudden death of animals which had received injections of non-protein foreign materials, and later typhoid vaccine, indicates that a change occurs in the immediate protective mechanism of the animals. This is also suggested by the intense bone marrow stimulation and pouring out of nucleated red blood cells into the circulation.

Evidence is rapidly accumulating to show that malfunction of the reticulo-endothelial system may result in varied clinical and pathologic manifestations.

There is some evidence to show that the cells of this group represent the cell type in certain leukemias. It is possible that they may form a group of rare tumors, variously termed reticulum cell sarcoma, endothelioma, angioma, etc.

Of particular interest, especially as regards the future of this method, is the work of Rowland, who has made a careful study of the relation between the reticulo-endo-

thelial cells and lipid metabolism. Some of the conclusions reached by him are as follows:

1. That such diseases as Christian's syndrome, which was first described as a disease characterized by defects in the membranous bones, exophthalmos, and diabetes insipidus; Niemann-Pick's disease, which is a rapidly developing generalized xanthomatosis of infancy, and Gaucher's disease, which is a similar condition with infiltration of more complex lipoproteins, all represent lipid metabolic diseases of the reticulo-endothelial system in which lipoids are stored in the reticulo-endothelial cells. Each of these conditions differs in clinical form and pathologic structure of the lesions and in the nature of the lipid concerned, but all are manifestations of the same pathologic process, perhaps modified by certain differences in the patient's general metabolic state.

The bone destruction, exophthalmos, diabetes insipidus, dwarfism, and infantilism, which are often present and are frequently regarded as evidence of disturbed *pituitary function*, are the results of this pathologic change. The same cause can be assigned for the less often observed *dystrophia adiposogenitalis*, and for certain confusing blood pictures.

2. That the nodular lesions with their varied pathologic changes (sometimes in a late stage of development not even showing foam cells) are hyperplastic new formations. This gives support to the opinion that a considerable number of yellow to yellowish-brown, lipid-containing, so-called endotheliomas, angiomas, giant-cell fibrosarcomas of the dura, periosteum, pleura, and peritoneum are not autogenous growths but are lipid storage tumors.

3. That recognition of the fact that the varied symptomatology is caused by pathologic changes resulting from hyperlipoidemia is important, since in this manner the pathogenesis of a number of other obscure conditions can be explained.

4. Finally, Rowland concludes that, when viewed in all its many forms, this lipid metabolic disease of the reticulo-endothelial system, which may be termed "lipoid gout," is by no means a rare condition.

Thorium is a very heavy metal which closely resembles radium in its chemical and physical properties. Like radium, it gives off three forms of radiation and an emanation differing chiefly in the rate of disintegration and, consequently, in the duration of the stages. While thorium gives off only the alpha rays, it breaks down very slowly into mesothorium, which gives off alpha, beta, and gamma rays. For this reason a specimen of thorium may continue to increase in activity for several years. Mesothorium changes in a day or so to emanation which lasts only a few minutes, whereas the emanation of radium lasts several days. The last stage of thorium, like that of radium, is probably lead. The chief effect of large doses is a change in the blood or blood vessels leading to multiple hemorrhages which may prove fatal. In man, death has resulted from the ingestion of an amount of thorium equivalent to 100 μ g. of radium.

A peculiar, severe, and often fatal chronic intoxication is seen in persons who use luminous paint containing about 20 per cent of radium and 80 per cent of mesothorium. Because the brushes used are frequently moistened with the lips it is estimated that as much as 27 gr. might be swallowed daily, containing up to 40 μ g. of radio-active substance. After a year or more, necrosis of the jaw and necrotic changes in the throat develop, associated with anemia of the pernicious type, which may prove fatal without further intake of the poison (Hoffman, Martland). Autopsy shows radio-activity of many tissues, most marked in the bones, and scattered petechial hemorrhages in the abdominal viscera.

Moderate doses, especially if injected,

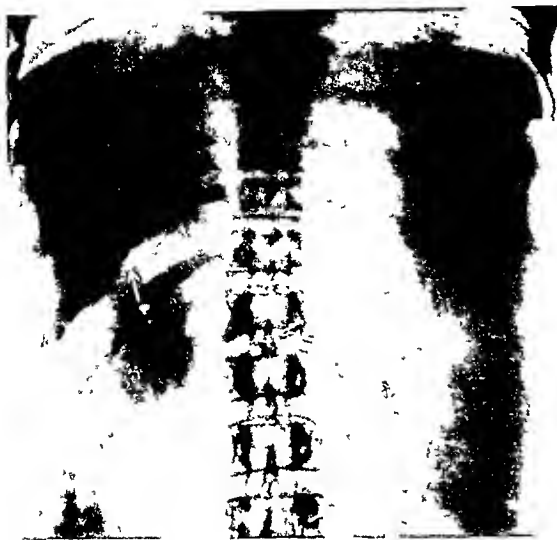


Fig. 5. Shows small liver (a) and a greatly enlarged spleen (b). The patient has had syphilis. The cause for the splenomegaly and small liver has not been determined.



Fig. 6. Shows enlarged liver. Note the more or less conglomerate annular defects in the liver shadow due to carcinomatous nodules. Annular defects, with increased density at the periphery, seem to be characteristic of carcinoma.

bring about striking changes in the circulating blood. The leukocytes are destroyed and in a day may fall to as low as 10 per cubic millimeter (Rosenow, Farber). The effect is chiefly exerted on the polymorphonuclears. There is delay in clotting time, and hyperemia, followed by degeneration of the blood-forming organs.

Certain products of thorium have been used in medicine for some time. Thorium nitrate and sulphate, which have astringent properties, have been used in the treatment of diarrhea. Weak solutions of thorium sulphate have been used in typhoid fever with reported good results. Thorium sodium citrate has been used for diagnostic purposes in pyelography and cystography. Thorium dioxide has been used in suspension as a medium in gastro-intestinal examinations. It is a heavy white powder, insoluble in water and dilute acids.

The contrast medium used in our work is a stabilized thorium dioxide sol, recently perfected by Kadrnka, and sold under the trade name of "Thorotrast." It contains 25 per cent of thorium dioxide sol (22 per

cent of thorium dioxide metal). In order to test the preparation for possible radioactivity, photographic films were exposed to it for 12 hours, but showed no effect. Samples were tested by the United States Bureau of Standards with negative results.

It is diluted in the proportion of 1 to 10, with 5 per cent glucose solution. It is opalescent, odorless, and has the consistency of heavy oil. A homogeneous solution can be produced by dilution with normal saline up to 1 to 8. It may also be used for cystography and pyelography.

In hepatosplenography, from 15 to 25 c.c. daily on three consecutive days is administered intravenously, the dosage depending upon the estimated size of the liver and spleen. In general, the density of the roentgen shadows of the liver and spleen will depend upon the quantity of the opaque medium administered and the anatomic and functional integrity of the cells that store it. If only the outlines of the liver and spleen are desired, the dose may be reduced one-half.

According to Kadrnka, the initial dose

should not exceed 0.1 gm. or 0.05 gm. per kilogram until on the average a total of 0.3 gm. of thorotrast has been administered per kilogram of body weight. Films may be made at any time after four hours following the last injection. On the night before the examination, the patient is given the usual evening meal and at bedtime 8 gms. of compound licorice powder. On the morning of the examination, a cleansing enema is given and the patient is advised to come to the roentgen department without breakfast. Films are taken on the Potter-Bucky diaphragm with the patient in both the prone and supine positions. The tube is centered over the ensiform cartilage. The following technic has been used by us in patients of average physique: 60 K.V.P. at 100 ma. for 3.5 seconds at 25 inch distance. In large individuals, in order to get good images of the spleen and liver on the same film, it is well to place the film transversely. The liver should cast a shadow of approximately the same density as the spine. The spleen normally should be slightly less dense.

In our clinic, 16 patients were subjected to this test. Three of these were children, one was 18 months of age, one six years, and one 11 years. The ages in the other patients varied from 35 to 55 years. Immediate or remote ill effects were not noted except in one case. A child six years of age, who had had a clinical diagnosis of tuberculous lymphadenitis, showed slight swelling about the eyes and mouth a few hours following the injection of 15 c.c. of thorotrast. Two patients died during the course of the examination. Both of these patients were in a semiconscious state before the administration of the medium and it is, therefore, felt that the test was in no way responsible for death. At autopsy, one of these patients showed cirrhosis of the liver and the other carcinoma of the head of the pancreas.

We were able in all cases to obtain a clear image of the liver and, in most cases, of the

spleen. Occasionally, if the spleen was small, its shadow could not be differentiated from that of the left lobe of the liver. The liver shadow was found to be of the same density as the spine, and the spleen of about the same density as that of the ribs. In one of our cases, a child 18 months of age, the liver and spleen were of approximately the same density as a barium-filled stomach. In the liver, clearly defined branching blood vessels were noted in several instances. Vessels which lie parallel with the rays appear as small, round or globular negative shadows. Structural changes in the spleen, as described by Radt, could not be demonstrated in our cases.

For the sake of simplicity we shall divide our cases into several groups, according to the various problems encountered.

The first group comprised four cases. In each case, a mass was palpable in the left upper quadrant of the abdomen. The question arose as to the nature of the mass, that is, whether it was splenomegaly or tumor. In all cases it was possible by this method to make a positive diagnosis of enlargement of the spleen. Furthermore, it was possible under fluoroscopic observation to visualize simultaneously the splenic shadow and to palpate the spleen.

In the second group of cases, we were confronted with the problem of confirming or disproving a clinical diagnosis of metastatic carcinoma of the liver. In two cases out of six examined, we were able to make a positive diagnosis of metastases. One of these was verified at autopsy. In the other the roentgen findings were so definite that there was little room for doubt. Of the remaining four cases, one showed an enlargement of the liver, but there was no autopsy. Another showed questionable metastases which have not as yet been verified or disproved. In another case, the films were not suggestive of metastases and an extensive tuberculous peritonitis was revealed at oper-

ation without evidence of involvement of the liver. In a fourth case, metastases were found neither in the radiographic examination nor at autopsy.

Carcinomatous nodules appear as areas of lessened density surrounded by a halo of greater density. The less dense areas can be explained by the fact that the cells in the carcinomatous nodules are unable to take up the medium. The increased density peripherally may be the result either of increased phagocytosis of the medium by these cells, or of a concentration of the cells about the nodules, as the result of pressure from rapid growth of cancer cells.

A third group consisted of two cases of leukemia associated with splenomegaly. The observations on these cases are still incomplete. We hope, however, to correlate the blood findings with the size of the spleen. The fact that the medium is in the liver and spleen for an indefinite time allows visualization of these organs at frequent intervals. In one of these two cases, a shadow, having the appearance of a Riedel's lobe, was noted.

In two cases of obstruction of the common bile duct, marked enlargement of the liver was found, but no alteration in liver structure could be discerned.

In the last group of cases, examinations were done in an attempt to show changes which were previously disclosed at operation. In one case, metastatic nodules in the liver were clearly demonstrated. In another case, a large hemangioma, which had been found one year previously at operation, was clearly defined. The absence of a dense halo about this tumor mass led us to believe that it was a benign tumor. There was merely an irregularly defined defect along the lower border of the liver.

An attempt was made to show changes in other organs containing reticulo-endothelial cells, *e.g.*, lymph nodes, bone marrow, hypophysis, etc. The concentration of the medium in these organs, however, was not suf-

ficiently great to show any alteration in structure.

In conclusion, our experience indicates that the use of this method offers possibilities of diagnosis hitherto unattained. Experience is as yet too limited to enable one to establish criteria of interpretation or to determine the possibility of remote harmful effects. We believe, however, both from theoretic considerations and practical experience, that it is probably as safe as other intravenous injections which are used routinely for diagnosis and therapy and that it opens up a new field for investigation which may have far-reaching results.

Note.—We desire to express our indebtedness to the staffs of Georgetown University Hospital, Children's Hospital, Gallinger Hospital, Garfield Memorial Hospital, Emergency Hospital, and Providence Hospital for co-operation in this study.

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DISCUSSION

DR. LEO GEORGE RIGLER (Minneapolis, Minn.): I have been much interested in this beautiful and comprehensive presentation of the subject, because we have had a limited experience along the lines that Dr. Otell described.

I might say that in the very small number of patients on whom we have used it, we have had no reactions that have been at all alarming. My assistant, Dr. Erickson, and our hematologist, Dr. Fallon, have been particularly interested in some cases of a rather rare blood disease called "reticulo-endotheliosis," in which the reticulo-endothelial system overacts in much the same way that we find the blood-forming organs over-acting in leukemia.

With the extension of these abnormal cells into the blood stream, we hoped, by the use of this material in one such case, to be able to demonstrate the change in function of the reticulo-endothelial system. Unfortunately, the patient was almost moribund at the time we were able to get him into the hospital for study.

We did find a striking result after a very small dosage. The leukocyte count, which had been around 3,000 or 4,000 (containing large numbers of abnormal cells), dropped to 500 after this dosage, although the patient felt much better and, for a short period, the abnormal cells stopped appearing in the blood stream.

We were struck by the fact that we did not get, in this particular case, as good shadows of the liver and spleen as we did in the normal individuals on whom we tried it. I think myself that there is a large field open for investigation.

We have done a certain amount of animal experimentation. In the rabbit one gets the most brilliant films of the spleen with delineation of the individual follicles. These can easily be studied.

In the Department of Physiology, at the

University of Minnesota, a great deal of work has been carried out with a view to visualizing the functions of the spleen, as has been done in many other institutions. We are particularly interested in changes in the size of the spleen under various conditions, such as after eating a meal and changes in blood volume. In the past they have been compelled to study these, of course, either by the use of measurements on the outside of the body—which is a relatively unsatisfactory method—or by making a window in the abdomen and observing the spleen through it—which is also relatively unsatisfactory.

We have just begun some work, which, from the experimental standpoint, we feel is going to be a remarkable advance in the ability to study the functions of the liver and spleen because of our ability to observe the changes in form and size under various conditions.

DR. EUGENE FREEDMAN (Cleveland, Ohio): I think there is a great field for the application of this method, not only in the diagnosis of different lesions in the reticulo-endothelial system, but also in making a differential diagnosis between certain lesions of the right upper quadrant, as, for instance, between liver abscess and subphrenic abscess, or between a subdiaphragmatic tumor and an encapsulated epidaphragmatic pleural effusion.

Not long ago a patient was admitted to the Cleveland City Hospital in an acute abdominal condition—high temperature, leukocytosis, spasticity of the abdominal muscles, and tenderness over McBurney's point. Clinically, a dull area was found at the right base. The question of differentiation between a subphrenic abscess and acute appendicitis came up.

The patient was fluoroscoped, whereupon the right diaphragm was found to be immobile, with a sharply defined, semicircular, bulging area at its dome. The roentgenologic diagnosis of subphrenic abscess was made, but, on tapping the subphrenic area at different places, no pus could be obtained. On account of this negative finding, the incision at the subsequent operation was made over McBurney's point and a badly inflamed distended appendix was found on the verge of rupture, and re-

moved. The patient made an uneventful recovery, but a subsequent re-examination still showed the semicircular shadow and immobile right diaphragm.

We were unable to make a definite diagnosis in this case, but considered two possibilities: A benign tumor of the liver (lipoma?) or a partial herniation of the liver through the diaphragm. In this case, the roentgenologic findings were certainly misleading.

I think, in similar conditions, this method will prove to be a great additional aid, if only it can be perfected to obtain good visualization of the liver and spleen in a shorter time.

DR. GROOVER (closing): Of course, we realize, in presenting this paper, that we are in no position to draw definite conclusions of the value of this test.

Before we began using it, the reticulo-endothelial system, to me, was little more than a name, and I am sure that is the case with many. The test at once impressed us with the great importance of these cells. Whether or not it turns out to be of practical value as a diagnostic procedure, it will stimulate interest in investigating the physiologic and pathologic properties of the reticulo-endothelial system.

"Atmosphere" of Atoms Known; Nucleus Still Unexplored.—Knowledge of the atom has increased immensely during the past few years; yet all the information scientists have gained is about the outer shell of electrons—the "atmosphere" of the atom. The nucleus, the inner core of the atom, where most of its mass is concentrated, is still a nearly unknown thing. This was the theme of an address on "The Assault on Atoms," delivered before the meeting of the American Philosophical Society by Prof. Arthur H. Compton, of the University of Chicago.

After reviewing the steps by which physicists have invaded the atom's atmosphere of electrons, Prof. Compton said that of all the scientific pictures of this part of the atom, the only adequate one is that proposed by the brilliant young German, Dr. W. Heisenberg. "according to which electrons move about more or less at random in the region of this atmosphere."

"Does this mean that the problem of the structure of the atom is solved?" Prof. Compton asked, and then answered: "Not yet. We feel that we know in general outline what this electron atmosphere is like; but there is the atomic nucleus. What is it?"

"It is the nucleus of the atom from which the alpha particle comes. The release of each such particle liberates a million times the energy released at the explosion of a molecule of T. N. T. Studies of these alpha rays indicate that around the nucleus of the atom exists an electrical wall which prevents outside alpha particles from entering and inside particles from leaving. The study of spectroscopy and radio-activity has given some information. Yet the nucleus of the atom, with its precious hoard of energy, presents a fascinating mystery. In this direction, probably, will turn the physics research of the next generation."—*Science Service*.

9. Idem: The Roentgenologic Demonstration of the Parenchyma of the Spleen and Liver by a New Colloidal Contrast Medium—Thorotrast—Introduced Intravenously. *Fortschr. a. d. Geb. d. Röntgenstr.*, 1931, XLIV, 9-15.

DISCUSSION

DR. LEO GEORGE RIGLER (Minneapolis, Minn.): I have been much interested in this beautiful and comprehensive presentation of the subject, because we have had a limited experience along the lines that Dr. Otell described.

I might say that in the very small number of patients on whom we have used it, we have had no reactions that have been at all alarming. My assistant, Dr. Erickson, and our hematologist, Dr. Fallon, have been particularly interested in some cases of a rather rare blood disease called "reticulo-endotheliosis," in which the reticulo-endothelial system overacts in much the same way that we find the blood-forming organs over-acting in leukemia.

With the extension of these abnormal cells into the blood stream, we hoped, by the use of this material in one such case, to be able to demonstrate the change in function of the reticulo-endothelial system. Unfortunately, the patient was almost moribund at the time we were able to get him into the hospital for study.

We did find a striking result after a very small dosage. The leukocyte count, which had been around 3,000 or 4,000 (containing large numbers of abnormal cells), dropped to 500 after this dosage, although the patient felt much better and, for a short period, the abnormal cells stopped appearing in the blood stream.

We were struck by the fact that we did not get, in this particular case, as good shadows of the liver and spleen as we did in the normal individuals on whom we tried it. I think myself that there is a large field open for investigation.

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University of Minnesota, a great deal of work has been carried out with a view to visualizing the functions of the spleen, as has been done in many other institutions. We are particularly interested in changes in the size of the spleen under various conditions, such as after eating a meal and changes in blood volume. In the past they have been compelled to study these, of course, either by the use of measurements on the outside of the body—which is a relatively unsatisfactory method—or by making a window in the abdomen and observing the spleen through it—which is also relatively unsatisfactory.

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That there are many clinicians who must still be convinced of the value of the roentgen diagnosis of chest conditions, is evidenced by an editorial in the *Canadian Medical Association Journal*.⁶ In it, the editor is constrained to consider both sides of the question, and he concludes, of course, that we are constantly growing more dependent on the X-ray, as the title says.

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ATELECTASIS AND COLLAPSE

The range of material on the two allied conditions, atelectasis and collapse, extends from spontaneous acute massive collapse through experimental and clinical observations following operative procedures and chronic conditions to theories concerning the etiology of the conditions.

Theoretical.—Two separate groups of investigators have presented theories on the etiology of atelectasis; both are plausible, but they conflict with one another. From animal experimentation and clinical observations, Van Allen and Lindskog^{14, 15, 16} observed that although plugging of a main trunk bronchus produces complete atelectasis of the lobe supplied by that bronchus, plugging of a smaller branch will not produce complete collapse. They predicate that this latter effect is due to exchange of air and gases between the alveoli at the periphery, which they term "collateral respiration." Coryllos and Birnbaum¹⁷ also report careful experimental observations carried out on dogs with the help of ingenious apparatus and a method for direct vision of the pulmonary changes occurring during the experiment. Their evidence would seem to indicate that "the mechanics of atelectasis are based on the physiology of the exchange of gases in the lung," and that "nitrogen in the respired air plays the part of a mechanical 'buffer,' retarding the absorption of more diffusible and more soluble gases." They adhere to the theory of occlusion as etiologic for atelectasis (that is, atelectasis results from occlusion of a lobar or common bronchus), but they feel that patchy atelectasis results from an inflammatory condition of the alveolar tissue and plugging. In other words, the etiology of atelectasis is controlled by the physical and chemical factors

⁵Am Jour Roentgenol and Rad Ther, January, February, March, 1932, XXVII, 153, 305, 479

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⁷Paul B Hoeber, New York, 1930

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¹⁶Jour. Orient. Med, November, 1931, XV, 83.

¹⁷Arch. Surg, December, 1930, XXI, 1214.

THIS is the first of a series of reports concerning progress in the various fields of radiology during the preceding year. The object of these reports will be to present, with the reviewer's comment, an abstract of the significant literature pertaining to the subject. Reports of a similar nature pertaining to other branches of medicine have appeared in various journals for several years, and have been of great value, particularly to physicians who do not have access to a large medical library. The increasing importance of radiology in all fields of medicine, and its natural division into

several specialized branches, has made it increasingly difficult for the general radiologist to keep informed of the significant literature of his specialty. Such a situation has suggested this report, which we hope will render a definite service to the profession.

The various reports have been compiled by radiologists whose work in their particular fields is well known. They have co-operated wholeheartedly and given freely of their time, in order that this report may fulfill its intended purpose.

JOHN D. CAMP, M.D.

PROGRESS IN RADIOLOGY DURING 1931: THE THORAX

By W. WALTER WASSON, M.D., DENVER

PART I, INCLUDING TUBERCULOSIS

RADIOLOGY has come to be such an integral part of the therapeutic and diagnostic armamentarium that there is scarcely a case reported or an article published in which one of its various phases is not used. The radiologic literature concerning the thorax, for the year 1931, has been voluminous. From more than six hundred articles examined, the 480 mentioned in the subsequent discussion represent only a portion of the material written during the past eighteen months, and they have been chosen to indicate experimental and observational advances. Dr. Rufus Cole¹ has said that "no period in history can be satisfactorily isolated from that which precedes and follows." This is especially true in reviewing the progress of a scientific subject as recorded in the publications. It is difficult to set arbitrary time limits; and this survey, supposedly of the progress in radiology for the year 1931, must necessarily

ly overlap a bit onto the end of 1930 and the beginning of 1932. An attempt has been made to classify the material according to the major subject interest.

There are two items of interest to all radiologists. The first of these is the erection of another monument to Professor Roentgen.² The monument, which was unveiled on November 30, 1931, is in Remscheid-Lennep, the birthplace of the scientist, and is the third to be erected in his honor. The second item is the Third International Congress of Radiology,³ which was held in Paris in the Summer of 1931. Dr. Bécélère, the president, presided; and there were 1200 delegates, although none of the German radiologists were able to attend because of the financial conditions.

General.—There are two publications of general interest in regard to the thorax. The first is Rigler's⁴ Outline of Diagnosis, and

¹The Harvey Lectures, Series XXV, The Williams and Wilkins Co., Baltimore, 1931, page 182.

²Jour. Am. Med. Assn., Jan. 10, 1931, XCVI, 128.

³Ibid., Sept. 12, 1931, XCVII, 790.

⁴Journal-Lancet, July 1, Aug. 1, Sept. 1, 1931, LI, 417, 478, 547.

the second is the excellent compendium on the action of the roentgen rays and radium on the heart and lungs by Desjardins.⁵ Both of these publications appear in serial form.

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of gas absorption and the physiologic integrity of the alveolar membrane.

Observational.—Korol^{18, 19, 20} has approached his studies from the clinical angle, and he bases his conclusions on observation of patients. He finds that massive atelectasis can occur without the occlusion of large bronchi. He feels that poor ventilation and the inactivity of the diaphragm are often the cause of atelectasis in patients who undergo prolonged recumbency. He finds it a common occurrence in tuberculosis, responsible for such important signs as contraction of the chest and lung, limited mobility, feeble or absent vesicular murmur, and a decreased complemental space. He also finds that when it is due to the compression of a bronchus it is a frequent accompaniment of certain intrathoracic conditions. Allen's²¹ observations on 94 surgical cases subjected to pre-operative and post-operative chest X-ray examinations show a unilateral high position of one hemidiaphragm in 43 per cent, and a bilateral high position of the domes in 57 per cent. He feels that the high position of one dome of the diaphragm may give the erroneous impression that atelectasis is present. He reports his findings because of the value in the diagnosis of post-operative chest films. Hennell²² finds that "in the so-called 'advanced unilateral fibroid phthisis' massive atelectasis of large portions of pulmonary tissue, occasionally involving most of one lung, is probably the essential mechanism of the evolution of the clinical and pathologic condition." Brown²³ feels that the term "partial atelectasis" is incorrect because "atelectasis is complete in any given area but is limited to a greater or lesser portion of the lung according to the magnitude or number of the bronchi that are obstructed," and he ad-

vises use of the terms of Lee and Tucker, with the addition of one of his own, for classification: (1) massive; (2) lobar; (3) lobular, and (4) scattered lobular (Brown). He has gained the impression from animal experiments and clinical observations that spinal anesthesia predisposes to post-operative pulmonary atelectasis.

Post-operative.—Brunn and Brill,²⁴ in a second report of their observations on every patient operated upon in the Clinic on Thoracic Surgery at the University of California Medical School, find atelectasis to be the predominating post-operative pulmonary complication. They find that the most important single factor in its production is bronchial obstruction. In one unusual case, they found localized bronchial edema.

Collapse.—Potter²⁵ defines collapse from several causes, but discusses only massive collapse due to tumor of a bronchus and collapse in pneumothorax. He reports two cases of the former and one of the latter, and concludes that because of the similarity of collapse and pneumonia there should be an X-ray examination of all surgical cases with pulmonary complications. He advises using postural treatment early in an effort to reinflate a collapsed lung, often without impairment of function. Jacobaeus and Westermarck²⁶ have continued their studies on massive collapse, and they report four cases among 25 of hemoptysis. There were several acute cases with bronchitis and three with bronchiectasis, five with chronic pulmonary tuberculosis without hemoptysis, and five of lung tumors with partial lobar collapse. They feel the collapse had a bad effect in their cases of chronic pulmonary tuberculosis.

Carbon Dioxide.—It is the belief of Henderson²⁷ that general use of carbon dioxide and oxygen in resuscitation and as a prophylactic measure immediately after birth,

¹⁸Am. Rev. Tuberc., September, 1931, XXIV, 276.

¹⁹Ibid., May, 1931, XXIII, 493.

²⁰U. S. Vet. Bur. Med. Bull., January, 1931, VII, 10.

²¹Radiology, April, 1931, XVI, 492.

²²Am. Rev. Tuberc., May, 1931, XXIII, 461.

²³Arch. Surg., June, 1931, XXII, 976.

²⁴Ann. Surg., November, 1930, XCII, 801.

²⁵Radiology, August, 1931, XVII, 271.

²⁶Acta Radiologica, 1930, XI, 547.

²⁷Jour. Am. Med. Assn., Feb. 14, 1931, XCVI, 495.

would materially reduce neonatal partial atelectasis, secondary asphyxia, pneumonia, and mortality. He feels that a simple inhalator for administering these gases is a necessary part of the equipment of every maternity hospital, and that similar apparatus should be accessible for rental in home deliveries.

BRONCHIECTASIS

In a second publication by Lloyd,²⁸ he refers to his former article on pulmonary atelectasis and the process by which an atelectatic area becomes fibrotic and there is consequent permanent loss in lung volume. In the latter article, he adds the other successive stages which he theorizes are the ones in the development of bronchiectasis. Boyd's²⁹ excellent survey of 56 cases of bronchiectasis in children brings out the point that although injection with an opaque medium is the ideal diagnostic procedure, there are times when such injection is impossible. Therefore, she thinks it is wise to know the usual X-ray signs. She prefers stereoscopic roentgenograms, but says the flat plate is also valuable. She notes certain suggestive evidence that aids in the diagnosis of early cases: (1) extensive fibrosis; (2) cardiac displacement; (3) blurring of the cardiohepatic angle; (4) enlargement of the hilus glands with no other evidence suggestive of tuberculosis. In well established cases, she mentions the characteristic "honeycombing," particularly in the lower lobes, as pathognomonic.

PNEUMOTHORAX

Palmer and Taft³⁰ define pneumothorax as the presence of air in the pleural cavity from any internal cause. They state that there are two types, idiopathic and that associated with pathology, and report five cases of spontaneous pneumothorax. The remainder of the publications on the subject con-

sists of cases reported because of rare complications, therapeutic procedure, etiology, or confusion in diagnosis.

ATELECTASIS: COLLAPSE: BRONCHIECTASIS: PNEUMOTHORAX—ADDITIONAL BIBLIOGRAPHY

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²⁸New England Jour. Med., Dec. 10, 1931, CCV, 1143.

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- viations from that normal. Fray^{31, 32} observed about seventy-five persons ranging in age from 8 to 72 years, and with heart conditions from the normal to the ultimate in pathology, death. The material was carefully evaluated, and his technique painstakingly established. His results embody the conclusion that the left postero-anterior oblique position offers the best opportunities for mensuration of heart size and enlargement. He is able to define the normal cardiothoracic index and that of the enlarged heart, and to determine the type of enlargement (right or left). Further work is in preparation for publication.

Experimental.—In the field of experimental research, the work of Businco and Cardia³³ in the production of pulmonary embolisms and the study of their distribution, offers interesting data. They used dogs, and their procedure entailed the injection of bismuth in oil into the jugular or femoral veins at regular intervals of from fifteen to twenty seconds until the animal was asphyxiated, which occurred in from five to fifteen minutes. They found that when the fluid was peripherally injected, it proceeded to the heart and was found in the lungs within from twenty to thirty seconds. It was usually seen chiefly in the basal portion of first one lobe and then in the same area of the other lobe, the right lower lobe being the most common site of first appearance. They conclude that gravitation evidently has an effect, that the origin and location of the original embolic process is probably of importance for the localization in the lung, and that the direction, length, width, and distribution of the right pulmonary artery are partly responsible for the predominant localization of embolisms in the right lower lobe.

Werthemann³⁴ studied the changes in the

CIRCULATORY SYSTEM

Mensuration.—Theoretically, the ideal method of instruction in any subject entails first a study of the normal, and then the de-

³¹*Am. Jour. Roentgenol. and Rad. Ther.*, February, 1932, XXVII, 177.

³²*Ibid.*, March, 1932, XXVII, 363.

³³*Fortschr. a. d. Geb. d. Röntgenstrahlen*, July, 1931, XLIV, 60.

³⁴*Strahlentherapie*, Nov. 29, 1930, XXXVIII, 702.

myocardium of rabbits following roentgen irradiation. He treated two series of animals; the only difference was the size of the area irradiated. Treatment was continued until death ensued, when histologic examinations of the hearts showed parenchymal changes consisting of degeneration and atrophy, with marked decrease of nuclei. There were also changes in the interstitial connective tissue consisting of extensive inflammatory infiltration with sclerosis. Zwaardemaker and Feenstra³⁵ report resuscitation of the heart of an eel or frog after it had stopped beating on account of removal of its permeable potassium salts. They irradiated the heart by means of a Grenz-ray tube (5 mm. distance, 4 ma.-hr.) and it started to beat again 28 minutes after and continued to beat for six hours. They believe this is the first series of experiments to show the electromagnetic roentgen rays have a similar effect upon the heart to the one from the corpuscular, alpha, and beta rays, as has been shown previously.

Uroselectan.—Salotti's³⁶ preliminary report on some of his studies with uroselectan is on the circulation in the lungs and hilum, and on the radiologic appearance of the superior vena cava. His findings are interesting, but he believes they will be of greater importance clinically when the technic is improved.

Azygos Vein.—Crosetti³⁷ reports five cases of azygos vein which he observed at his clinic for the study of tuberculosis, using teleradiography with an exposure of one-tenth second. He points out that both statistics and interpretation of radiographs are somewhat contradictory, and believes that the difficulty encountered in the interpretation of a film is due either to the lightness of the opaque band of the meso-azygos or to its unusual location, and that it is easy to mistake the image of the vein for shad-

ows of old sclerotic lesions or calcified nuclei. The anomaly may cause an hypophonia of different intensities in the corresponding apical field. This sign should be a further aid to the semeiotic control, but it must be confirmed by appropriate radiologic examination.

Pulsation.—Gas in the pleura, even in small amounts, causes the heart pulsation to take on the appearance of an oscillating or spring contraction, and increases the speed of the heart excursion. Vallebona's^{38, 39} description of spring pulsation is illustrated with roentgenograms of cases which support his theory that the condition is due to withdrawal of the lung pressure from the heart.

Coarctation of the Aorta.—The roentgen diagnosis of coarctation of the aorta is possible and practicable. This fact is emphasized by an editorial⁴⁰ in which the diagnostic signs are reiterated. These are: (1) a defect in the continuity of the arch, and (2) erosion of the ribs posteriorly. To detect the defect, both roentgenoscopic and roentgenographic examinations are necessary, and also postero-anterior left oblique roentgenograms. Ernstene and Robins⁴¹ report a case that showed extensive erosions of the inferior borders of the ribs bilaterally, an excellent reminder of the efficacy of the roentgen examination.

Syphilis.—Electrocardiographic records of 27 adult cases of early syphilis studied by Ingraham and Maynard,⁴² at the Cardiac Clinic of the Brooklyn Hospital, showed that the tracings fell within normal limits. Of 23 of these patients studied by teleroentgenograms, six showed slight widening of the aorta, but not beyond the limits of normal deviation. The study by Kurtz and Eyster⁴³ of 54 cases of acquired syphilis and 12 of the congenital type seems to indicate that

³⁵Arch. di radiol., 1930, VI, 827

³⁶Am. Jour. Roentgenol. and Rad. Ther., March 1931, XXV, 383.

³⁷Ibid. February, 1931; XXV, 243

³⁸Am. Heart Jour., October, 1930, VI, 82

³⁹Ibid. October, 1930, VI, 67.

³⁵Strahlentherapie, 1930 XXVI, 368

³⁶Arch. di radiol., May-June, 1931, VII, 633

³⁷Minerva med., April 21, 1931, XXII, 606

fluoroscopic examination is more reliable as a diagnostic procedure. In the acquired form, they found evidence of aortitis in 90.7 per cent, aneurysm of the aorta in 18.5 per cent, and cardiac enlargement in 38.9 per cent. In the congenital form there was evidence of aortitis in 36.4 per cent, and aneurysm of the aorta was absent in all. In an additional group of 23 cases of acquired syphilis, in whom central nervous system disease was exhibited primarily, aortic involvement was evidenced in 95.7 per cent, and aneurysm could be demonstrated in 21.8 per cent. Hampton, Bland, and Sprague⁴⁴ describe the method of study of the aorta which is in use now at the Massachusetts General Hospital, and which they believe is valuable even in cases in which the clinical impression is unknown to the roentgenologist. From measurements made with their technic, they feel justified in deducing the normal and arteriosclerotic aorta with dilatation. From his review of 40 proved cases, Steel⁴⁵ thinks that syphilitic aortitis can be suspected when a diffuse dilatation is present and is associated with a normal-sized heart silhouette; or when a dense high aorta is present in a young individual without previous hypertension, he believes the condition may be safely diagnosed when localized dilatation associated with localized increased pulsation is demonstrated.

Radiotherapy.—Freund⁴⁶ has used radiotherapy in diseases of the heart since 1906 when he treated a case of insufficiency and stenosis of the mitral valve with good results. Since that time he has also had good results from treatment with the mercury vapor light and ultra-violet irradiation in cases with angina pectoris and disturbances of compensation. He says that in his case of organic heart disease the result was not conclusive, but that others report good results in similar conditions.

Case Reports.—Among the case reports of rarities are: one of hydropneumopericardium which evinced the characteristic splashing sound;⁴⁷ eight cases of pericarditis with effusion;⁴⁸ one of aneurysm of the pulmonary artery;⁴⁹ three cases of passive congestion of the lungs in the presence of coronary sclerosis,⁵⁰ and one case of persistence of the right-sided aortic arch which was demonstrated by careful roentgen examination.⁵¹

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⁴⁴*Am. Heart Jour.*, October, 1930, VI, 77.

⁴⁵*Ibid.*, October, 1930, VI, 59.

⁴⁶*Strahlentherapie*, 1930, XXXVI, 516.

⁴⁷*Jour. Am. Med. Assn.*, Jan. 17, 1931, XCVI, 187.

⁴⁸*Am. Jour. Dis. Child.*, January, 1931, XII, 78.

⁴⁹*Surg., Gynec. and Obst.*, June, 1931, LII, 1129.

⁵⁰*Radiology*, August, 1931, XVII, 342.

⁵¹*Fortschr. a. d. Geb. d. Röntgenstrahlen*, August, 1931, XLIV, 163.

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FUNGUS DISEASE

The literature on fungus disease of the lung is constantly increasing. Although the diagnostic signs for the roentgenologist are often reiterated, the consensus of opinion is that the final positive diagnosis is dependent upon the laboratory findings. Most of the material on this condition appears as case reports. Good⁵² adds 13 more cases to the number already recorded as actinomycosis. His youngest patient was two and one-half years old. Stöve⁵³ found the roentgen examination negative in his patient, a boy of fourteen years, who was sent to the clinic with a diagnosis of chronic pulmonary tuberculosis with perforated pleural empyema. He made his diagnosis from the sputum ex-

amination and the tuberculin reaction. Siebert⁵⁴ reports another case of actinomycosis in which the strong fetid odor was an especially characteristic symptom. The clinical course and the roentgenogram were deceiving. Forman's⁵⁵ case was diagnosed from the admission roentgenogram. After iodide and vaccine therapy, the final X-ray examination showed an essentially negative chest, and recovery was assumed. On the other hand, Lüdin⁵⁶ reports that potassium iodide was not effective in the treatment of his case of actinomycosis, with involvement of the left lower lung and fistula formation. He used roentgenotherapy (four fields over the diseased part of the lungs; each received 200 r, 160 K. V., 8 mm. Al, 25 cm. F.S.D., 10 × 10 sq. cm. field), and after the first series, there was closure of the fistula, temporary disappearance of pain, and improvement of the general condition. Following the second series, there was a clinical cure. He suggests the use of the same dosage in similar cases. Kirklin and Hefke⁵⁷ report 14 cases of thoracic actinomycosis observed at the Mayo Clinic. They describe the roentgen changes in detail, and state that pulmonary and pleural lesions associated with areas of destruction in portions of the ribs or sternum, with or without osteomyelitis and periostitis, constitutes a combination which is the sole roentgen syndrome that is more or less diagnostic, or at least strongly indicative. They believe that careful roentgen examination of the thorax, in all known cases of actinomycosis, would probably lead to earlier discovery of thoracic involvement and to better therapeutic results.

During the routine examination of 18,825 persons, Sayers and Meriwether⁵⁸ found about 125 cases of typical miliary lung disease as revealed by the X-ray examination. Of 88 of these persons whose sputum was

⁵²*Arch. Surg.*, November, 1930, XXI, 786.

⁵³*Arch. f. Kinderh.*, Oct. 21, 1930, XCI, 241.

⁵⁴*Deutsche med. Wchnschr.*, May 29, 1931, LVII, 936.

⁵⁵*Jour. Med. Assn., South Africa*, Aug. 22, 1931, V, 515.

⁵⁶*Strahlentherapie*, Oct. 24, 1931, XLII, 466.

⁵⁷*Am. Jour. Surg.*, July, 1931, XIII, 1.

⁵⁸*Pub. Health Rep.*, Dec. 5, 1930, XLV, 2994.

examined, tubercle bacilli were present in two. In 31 cases in which unstained smears were made, fungi of two types were identified—*Aspergillus fumigatus fisheri* and *Aspergillus niger*. The report of five cases of yeast infection of the lungs by Healy and Morrison⁵⁰ stresses again the necessity for careful laboratory examinations because of the similarity to pulmonary tuberculosis in both clinical and roentgenologic pictures. Barbero⁶⁰ felt that mycosis was a common complication of pulmonary tuberculosis, and his cultures from 54 patients with pulmonary tuberculosis confirmed his contention.

PNEUMOCONIOSIS

Because of their commercial importance, the pneumoconioses have been the cause of considerable study. Investigation was begun to discover what might be termed the etiologic occupations. In this connection, Cooke⁶¹ found pneumoconiosis due to flue dust; Lawson, Jackson and Gardner⁶² found it in iron miners, and Gudjonsson⁶³ found silicosis among women employed in the manufacture of scouring powder. One of the outstanding features of the condition is that symptoms may not develop until some years after the exposure to the causative agent has ceased. Britton and Head⁶⁴ report four such cases in which the interval between exposure and development of symptoms was from ten to twenty-three years. In 1925, Pancoast and Pendergrass reviewed the subject of pneumoconiosis; and in 1931 they have published a second review,⁶⁵ in the latter, limiting themselves to the advances made since the former. They stress the economic phases, the newness of the subject, the importance of the roentgen examination, and the necessity for the roent-

genologist to familiarize himself with the roentgen picture. They also suggest a new pathologic-roentgenologic classification.

Asbestosis.—One of the etiologic occupations which produces chronic pulmonary disease is work in asbestos. Lynch and Smith⁶⁶ survey the literature and describe the condition in detail. They found only 173 cases of pulmonary asbestosis previously reported in the literature, six of which were their own, and they add one more. They base their diagnosis on the clinical, roentgen, or necropsy findings. Clinically, they examine the sputum or lung juice obtained by puncture, for the presence of asbestosis bodies. In December, 1930, there appears the report of a case by Soper⁶⁷ which he diagnosed by demonstration of the bodies in the sputum. Lynch and Smith did not mention it. Stewart, Bucher, and Coleman⁶⁸ also report two more cases of asbestosis. In their first case, the symptoms were relatively unimportant; in the second, the disease was concomitant with tuberculosis. They found asbestosis bodies may be harbored by the spleen and lymph nodes as well as by the lung. They urge study in order to prevent the disease.

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⁵⁰Am. Jour. Roentgenol. and Rad. Ther., September, 1931, XXVI, 498.

⁶⁰Rev. esp. de tuberc., June, 1931, II, 253.

⁶¹Brit. Med. Jour., November, 1930, II, 816.

⁶²Jour. Am. Med. Assn., April 4, 1931, XCVI, 1129.

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⁶⁴Jour. Am. Med. Assn., June 6, 1931, XCVI, 1938.

⁶⁵Am. Jour. Roentgenol. and Rad. Ther., October, 1931, XXVI, 556.

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⁶⁷Ibid., December, 1930, XXII, 571.

⁶⁸Arch. Pathol., December, 1931, XII, 909.

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THYMUS

In spite of the "passing of Status Lymphaticus," as the London Correspondent of the *Journal of the American Medical Association*⁶⁹ terms it, in commenting on the report of the joint committee⁷⁰ (of the Medical Research Council and the Pathological Society of Great Britain and Ireland), valuable material concerning the thymus glands is constantly appearing. Boyd,⁷¹ reporting to the White House Conference on the growth and function of the thymus, states that the roentgen information has not been as carefully analyzed as has other information on the gland. She feels there is a need for standards based on healthy symptom-free children. Fanconi's⁷² discussion of the pathology of the superior mediastinum is especially pertinent in the evaluation of thymic enlargement. He shows that since the roentgenogram is the result of a superposition of the sternum, thymus, large vessels and the vertebræ, it may be disturbed by variations in any of them. He says narrowing is especially characteristic of transposition

of the great vessels, and that the chief cause of widening is thymic hypertrophy. He also discusses the significance of various lines within the mediastinal outline. Krizenky's⁷³ experimental work on pigeons permits him to conclude that the thymic gland acts as a regulator of thyroid function. Dustin and Grégoire⁷⁴ note that the thymus of irradiated pregnant guinea pigs evidences a state of involution which increases with the age of the animal and the length of pregnancy. In the thymus glands of fetuses of these females, radiation produces rapid and massive pyknotic degeneration. When the small thymic cell is developed it at once acquires a decided hypersensitivity to radiation. After radiation, Hassall's corpuscles develop all along the vascular framework and undergo considerable hyperplasia. Kennedy and New⁷⁵ discuss conditions that may produce chronic stridor "sometimes erroneously attributed to enlargement of the thymus." Pancoast⁷⁶ feels that the "thymic menace" in infants and children is largely a matter of tracheal stenosis, and consequently he offers a new technic for the roentgen examination. Donaldson⁷⁷ reports on 1,045 patients with hyperplasia of the thymus. He found a tendency to familial enlargement, but doubted if there was a connection between the "thyroid mother and the thymic infant." The mother's age, multiparity and obesity of the parents, had no bearing on the size of the thymus in the child. He urges early diagnosis as vital and advises treatment, but his technic is poorly outlined. Frank⁷⁸ treats only if there are symptoms of pressure. Johnston and Howard⁷⁹ feel that in an infant who presents noisy, difficult, or rapid breathing, it is necessary to rule out other cause before narrowing down to a di-

⁶⁹Compt. rend. Soc. de Biol., Feb. 6, 1931, CVI, 325.

⁷⁰Ibid, Sept. 18, 1931, CVII, 1565.

⁷¹Jour. Am. Med. Assn., April 18, 1931, XCVI, 1286.

⁷²Am. Jour. Med. Sci., December, 1930, CLXXX, 745.

⁷³Am. Jour. Roentgenol. and Rad. Ther., November, 1930, XXIV, 523.

⁷⁴Jour. Am. Inst. Homeop., June, 1931, XXIV, 553.

⁷⁵Jour. Michigan St. Med. Soc., November, 1930, XXIX, 772.

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⁷⁰Jour. Path. and Bact., March, 1931, XXXIV, 213.

⁷¹Am. Jour. Dis. Child., July, 1931, XLII, 205.

⁷²Schweiz. med. Wchnschr., March 7, 1931, LXI, 229.

agnosis of thymic enlargement. When convinced of the necessity, they treat, but since they feel that thymic enlargement responds rapidly to X-ray therapy, if there is not immediate improvement they doubt the diagnosis.

Psoriasis.—Speirer⁵⁰ reports ten years' experience in the treatment of psoriasis by roentgenography of the thymus. He did not obtain a single permanent cure among 50 cases treated, although he noted temporary disappearance of lesions in a few. There were recurrences within a year, those who did respond were mostly young patients, sex and variations of technic were not factors. He feels that there may be a connection between psoriasis and tuberculosis because of the beneficial effects following exposure over the upper mediastinum which could be due to an effect upon the glands in that region, since it is well known that tuberculous glands respond to treatment. He does not believe there is any stimulation effect.

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TUBERCULOSIS

As usual, the amount of material pub-

lished on the subject of tuberculosis is staggering, and much of it is repetitious. Due to the limited amount of space, any material not pertinent to the radiologic angle has been eliminated.

Diagnosis.—The diagnosis of pulmonary tuberculosis is a moot subject. The early infiltrations and diagnosis of the disease in both children and adults have received a large amount of attention. Meyer⁵¹ writes on what he terms "pretuberculosis," and Ligner⁵² calls the pre-allergic period that interval of from three to five weeks during which infection by the air route is without sign until the appearance of allergy. This is accompanied by a triad—sensitiveness to tuberculin, a period of fever, and a thickening of the hilus in one lung or the other. Reid,⁵³ Wiewiorowski and Bödecker,⁵⁴ Brauening,⁵⁵ and Delherm and Thoyer-Rozat⁵⁶ all urge the periodic radiologic examination of apparently healthy persons as a means of revealing previously unsuspected tuberculosis. They feel the early treatment which must necessarily ensue is an important public health and preventive disease measure. Lawrason Brown⁵⁷ is convinced the roentgen examination will reveal lesions of the disease long before it is manifested in any other way, while Sampson's and his⁵⁸ experimental and statistical studies prove the efficacy of roentgen examination for pulmonary tuberculosis. Stayton⁵⁹ and Menville⁶⁰ second Brown's statement, but the former also believes the roentgen and clinical examinations should be entirely independent of each other, while the latter urges more encouragement of frequent consulta-

⁵¹Med. de los niños, January, 1931, XXXII, 6.

⁵²Ztschr. f. Kinderh., 1930, L, 505.

⁵³New York St. Jour. Med., March 15, 1931, XXXI, 337.

⁵⁴Fortschr. a. d. Geb. d. Röntgenstr., June, 1931, XLIII, 679.

⁵⁵Ztschr. f. Tuberk., May, 1931, LX, 273.

⁵⁶Paris médical, Feb. 7, 1931, I, 117.

⁵⁷Am. Jour. Med. Sci., November, 1931, CLXXXII, 703.

⁵⁸Am. Jour. Roentgenol. and Rad. Ther., February, 1931, XXV, 209.

⁵⁹Indiana St. Med. Assn. Jour., Feb. 15, 1931, XXIV, 85.

⁶⁰New Orleans Med. and Surg. Jour., December, 1930, LXXXIII, 370.

⁵⁰Strahlentherapie, 1931, XL, 272.

tion between internist and roentgenologist. Casati⁹¹ notes three principal causes of error to explain the lack of agreement between the clinical and roentgenologic observations in pulmonary tuberculosis. These are: (1) the absence of complete agreement between the roentgen observations and the pathologic anatomy; (2) absence of agreement between the clinical and the anatomopathologic observations, and (3) a certain fixed nature of the roentgen picture in the sense that the anatomopathologic lesions change slowly in the roentgenogram, more slowly than in the clinical picture. Pai⁹² feels that roentgenology has great advantages over physical means in the diagnosis of tuberculous hilus disease, circumscribed pneumothoraces, pleural effusions, and occluded cavities. Basu⁹³ considers the roentgenologic examination of the lungs superior to the physical in the following conditions: (1) early tubercle complicated by bronchitis; (2) deep-seated and closed early lesions; (3) hilum tuberculosis; (4) recrudescences of old lesions, and (5) necessity for artificial pneumothorax therapy. He advises correlation of both examinations. Wulff and Myers⁹⁴ cite two groups of cases in which they feel that the chest findings warrant far more consideration than they usually receive. The first group includes patients who have mild symptoms from time to time, but in whom no evidence of pathology can be detected other than definite calcium deposits in the hilus region with or without accompanying Ghon tubercles. The second group comprises patients with the same findings but in whose families tuberculous infection has spread to nearly all the members, and in which one or more clinical cases of tuberculosis has developed. Zihelnik's⁹⁵ study of a large number of ambulatory patients who had been diagnosed as having pulmonary tu-

berculosis prompts him to urge constant demonstration to the "ambulatory physician" of the importance and necessity of the most extensive use of roentgenography in suspicious cases.

The primary focus of tuberculous infiltration is also a considerably discussed point. Fleischner⁹⁶ is inclined to belief in the "Frühinfiltrat" of Assmann and Redeker which he describes as a decidedly exudative focal picture. He says that the diagnosis is more often made by roentgenologic than by clinical means because of the lack of definite outstanding clinical signs. Infraclavicularly, there is a pale, patchy shadow of different densities. The position of the focus may be higher, but seldom in the apices. It often lies deep in the upper lobes, and occasionally in the apices of the lower lobes. Very early foci show homogeneous, distinctly outlined shadows. Shadows striating toward the hilus often lead to the impression of lymphangitis and the inflammatory edemas of the large perivascular and peribronchial interstices. Sorrentino's⁹⁷ examination of 1,000 tuberculous patients, in whom he found 20 cases of the infiltrate in its pure form, would seem to substantiate its importance. Staub⁹⁸ urges that both it and apical tuberculosis be sought for. It is questionable how sound is the basis for Fischel's⁹⁹ controversial statement that apical tuberculosis as a rule is a benign late form. Sagona's¹⁰⁰ experimental work indicates that the tubercle bacillus in small doses or as ultravirus has a special predilection for the lymph nodes. Herrman¹⁰¹ says that, roentgenologically, the primary focus of infection should manifest itself as an infiltrative process, but the majority of cases show reinfection foci with perifocal infiltration which may appear in any part of the lung.

⁹¹Gior di Clin Med., Feb 28, 1931, XII, 157

⁹²Antiseptic, July, 1931, XXVIII, 506

⁹³Ibid., July, 1931, XXVIII, 510

⁹⁴Med Jour and Record, Dec 3, 1930, CXXXII, 527

⁹⁵Vrachebnaya Gazetta, April 15, 1931 VII, 501

⁹⁶Wien klin Wchnschr., Feb 20, 1931, XLIV, 267

⁹⁷Rif Med., Feb 23, 1931, XLVII, 285

⁹⁸Schweiz med Wchnschr., Feb 14, 1931, LXI, 157

⁹⁹Am Rev Tuberc., February, 1931, XXIII, 139

¹⁰⁰Riv di Pat Clin di Tuberc., Aug 31, 1931, V, 670

¹⁰¹Kentucky Med Jour., August, 1931, XXIX, 393

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Diagnosis.—The diagnosis of pulmonary tuberculosis is a moot subject. The early infiltrations and diagnosis of the disease in both children and adults have received a large amount of attention. Meyer⁵¹ writes on what he terms "pretuberculosis," and Ligner⁵² calls the pre-allergic period that interval of from three to five weeks during which infection by the air route is without sign until the appearance of allergy. This is accompanied by a triad—sensitiveness to tuberculin, a period of fever, and a thickening of the hilus in one lung or the other. Reid,⁵³ Wiewiorowski and Bödecker,⁵⁴ Brauchning,⁵⁵ and Delherm and Thoyer-Rozat⁵⁶ all urge the periodic radiologic examination of apparently healthy persons as a means of revealing previously unsuspected tuberculosis. They feel the early treatment which must necessarily ensue is an important public health and preventive disease measure. Lawrason Brown⁵⁷ is convinced the roentgen examination will reveal lesions of the disease long before it is manifested in any other way, while Sampson's and his⁵⁸ experimental and statistical studies prove the efficacy of roentgen examination for pulmonary tuberculosis. Stayton⁵⁹ and Menville⁶⁰ second Brown's statement, but the former also believes the roentgen and clinical examinations should be entirely independent of each other, while the latter urges more encouragement of frequent consulta-

⁵¹*Med. de los niños*, January, 1931, XXXII, 6.

⁵²*Ztschr. f. Kinderh.*, 1930, L, 505.

⁵³*New York St. Jour. Med.*, March 15, 1931, XXVI, 337.

⁵⁴*Fortschr. a. d. Geb. d. Röntgenr.*, June, 1931, XLIII, 679.

⁵⁵*Ztschr. f. Tuberk.*, May, 1931, LX, 373.

⁵⁶*Pans médical*, Feb. 7, 1931, 1, 117.

⁵⁷*Am. Jour. Med. Sci.*, November, 1931, CLXXXII, 700.

⁵⁸*Am. Jour. Roentgenol. and Rad. Ther.*, February, 1931, XXV, 202.

⁵⁹*Indiana St. Med. Assn. Jour.*, Feb. 15, 1931, XXIV, 85.

⁶⁰*New Orleans Med. and Surg. Jour.*, December, 1930, LXXXIII, 370.

⁶⁰*Strahlentherapie*, 1931, XI, 272.

the hilus and an accurate diagnosis of hilus involvement is impossible without it. Les-tocquoy¹¹⁵ feels that the monthly roentgen examination of tuberculous children is absolutely necessary, and Stone and Wolff¹¹⁶ found that by means of the X-ray the positive diagnosis of tuberculosis was established in 28 per cent more of the children they studied than by any other method. From their study of 1,000 adolescent school children in New York City, Barnard, Amberson, and Loew¹¹⁷ rank the X-ray examination as of great value, and Forbes, Verploeg, and Bazemore¹¹⁸ conclude from their survey in the schools of a small Colorado town whose pupils were mostly tuberculosis contacts, that symptoms of fatigue and underweight and a history of frequent colds were not reliable in the diagnosis of the childhood type of tuberculosis. Hetherington and his associates,¹¹⁹ studying medical and college students by means of the roentgen and other examinations, report a high incidence of apical tuberculous lesions in the medical students. These increase rapidly from the age of twenty-one to twenty-six years, and indicate that medical students are peculiarly subject to advanced tuberculous infection. Myers¹²⁰ article showing the increase in tuberculin-positive reactors among nurses and students of medicine after exposure in tuberculous services, has created considerable comment.

Basic Material.—There are several good basic articles on tuberculosis in childhood which are valuable, not because of necessarily new material, but because of the sound reasoning behind the information they reiterate. The authors are Hempelmann,¹²¹ Chadwick,^{122, 123} and Krause.¹²⁴

The last named is opposed to too much attempt at classification; he feels it is sufficient to term a condition "active" or "inactive."

Classification.—In regard to classification, Ornstein, Ulmar, and Dittler¹²⁵ describe a condition which they call "benign acute pulmonary tuberculosis," the chief characteristic of which is that it disappears completely within from a few weeks to a few months, with complete healing. They report 58 cases, with a description of typical histories, symptoms, physical signs, roentgen findings, and treatment. In a second article,¹²⁶ they offer a new classification for pulmonary tuberculosis because they believe the one now in use does not indicate the possibility of the patient's recovering. Shipman¹²⁷ merely substantiates the use of the "exudative-proliferative" classification. Sims¹²⁸ thinks that although there are many classifications of pulmonary tuberculosis, both clinical and pathologic, the most logical one to him is the one based on the pathologic stage or phase of the disease; exudative infiltration and caseation, including cavitation; fibrotic infiltration, and calcification. Henricke¹²⁹ is averse to any more classifications of tuberculosis, because of the number already extant, but, after due consideration, he offers another which he feels conforms to the present terminology and knowledge. The name he suggests is "benign infiltrations in the childhood type of epituberculosis," and he suggests four classes: (1) massive infiltrations (splenopneumonia); (2) lobar infiltrations (the epituberculosis of Eliasberg and Neuland, *Jahr. f. Kinderh.*, 1920, XCIII, 88); (3) perihilar infiltrations, and (4) perifocal infiltrations. He believes the condition presents a symptom-complex which is just as interesting as it is poorly

¹¹⁵Médecine, May, 1931, XII, 361

¹¹⁶RADIOLOGY, November, 1931, XVII, 940.

¹¹⁷Am. Rev. Tuherc., May, 1931, XXIII, 593.

¹¹⁸Am. Jour. Dis. Child., January, 1931, XLI, 26

¹¹⁹Arch. Int. Med., November, 1931, XLVIII, 734

¹²⁰Jour. Am. Med. Assn., Aug. 1, 1931, XCVII, 316

¹²¹Jour. Missouri St. Med. Assn., November, 1930, XXVII, 519.

¹²²Jour. Mich. St. Med. Soc., January, 1931, XXX, 15.

¹²³Am. Jour. Roentgenol. and Rad. Ther., January, 1932, XXVII, 46.

¹²⁴Ann. Int. Med., May, 1931, IV, 1424.

¹²⁵Am. Rev. Tuherc., March, 1931, XXIII, 223.

¹²⁶Ibid, March, 1931, XXIII, 248.

¹²⁷Calif. and West. Med., March, 1931, XXXIV, 172.

¹²⁸New Orleans Med. and Surg. Jour., March, 1931, LXXXIII, 631.

¹²⁹Northwest Med., March, 1931, XXX, 109.

The amount of inflammatory change appearing as an allergic reaction depends on the degree of the patient's immunity. De-Benedetti¹⁰² thinks that tuberculous "hilitis" enters into the picture of the primary infection in children and is the typical roentgen expression. Schulz¹⁰³ uses the oblique roentgenogram to demonstrate enlarged bronchial lymph nodes which he believes to be the site of tuberculous infection in adults much more often than is thought.

Public Health—That tuberculosis is inherently a public health problem is amply evidenced by the increased interest in its control which is being exhibited by local and national public health agencies both in the United States and elsewhere. There are reports of current problems and advances from Germany, Italy, France, England, Denmark, Sweden, Hawaii, and the Netherlands. Italy held its fourth National Congress for the Crusade against Tuberculosis¹⁰⁴ in Bologna, in October, 1931; the fourth Polish Conference on Tuberculosis¹⁰⁵ was held at Zakopane in September, 1931, and the Roumanian League against Tuberculosis held its first National Congress¹⁰⁶ in July of that year.

Wingfield¹⁰⁷ is interested in the general practitioner's clinical problem with the child in the tuberculous household. He urges proper hygiene in the home, but he feels that it is a serious responsibility and "would be a waste of his time and injurious to his practice" for the physician to say to a tuberculous mother that she must never see her child again. He believes that the adolescent period is the most dangerous one and that then the roentgenogram is particularly useful, for "apical infiltration in childhood and adolescence, although apparently latent, always goes on to definite clinical pulmonary tuberculosis if untreated." Dis-

on,¹⁰⁸ on the other hand, stresses the communicability of tuberculosis and the fact that it is, therefore, a family disease. He urges removal of children from homes which have a source of infection. Klein¹⁰⁹ calls attention to the necessity for health examinations of teachers and of students in pedagogic institutes, because of the danger of subsequent contact for children in their classes. His work is based on experience with several class infections which could be traced to teachers with open tuberculosis.

Value of Roentgen Examination—There are a number of surveys of tuberculosis in adults and children. Although Eberson, Delprat, and Wolff¹¹⁰ conclude that the roentgen evidence is of no value for the diagnosis of tuberculosis unless associated with other positive signs; and Paolucci and Busi,¹¹¹ reporting their findings on 300 children in a small Italian town with a known high incidence of tuberculosis, warn against placing too much emphasis upon the roentgen findings, the majority of investigators all over the world are commendatory of the importance and value of the roentgen examination in diagnosis. Filgueiras,¹¹² of Rio de Janeiro, feels that roentgenograms are the best means of diagnosis in early infancy. Budson¹¹³ reports that Armand-Delille considers the X-ray to be the only positive diagnostic means for the early recognition of enlarged tracheobronchial glands, and Alt-schul¹¹⁴ says that although the roentgen diagnosis of tuberculosis of the bronchial glands is not reached as often as it should be, especially in children, and although certain groups of glands cannot be exhibited in the roentgenogram because they fall within the middle shadow, nevertheless the roentgen examination constitutes the most important part of the whole examination of

¹⁰²Ibid., April 25, 1931, I, 604.

¹⁰³Ztschr. f. Tuberk., December, 1931, LXIII, 22.

¹⁰⁴Am. Jour. Dis. Child., October, 1930, XL, 8-1.

¹⁰⁵Bull. Union Internat. Tuberc., 1930, VII, 2.

¹⁰⁶Arch. Pediat., January, 1931, II, 77.

¹⁰⁷Jour. Michigan St. Med. Soc., January, 1931, XXX, 19.

¹⁰⁸Radiology, December, 1931, XVII, 114.

¹⁰⁹Clin. Ped., October, 1931, XIII, 769.

¹¹⁰Ztschr. f. Tuberk., March, 1931, LX, 24.

¹¹¹Jour. Am. Med. Assn., Sept. 12, 1931, XCVII, 793.

¹¹²Ibid., March 5, 1932, XCVIII, 830.

¹¹³Ibid., Sept. 12, 1931, XCVII, 792.

¹¹⁴British Med. Jour., Oct. 31, 1931, II, 787.

ties of interpretation roentgenographically. The disease was rather sharply limited to a part or the whole of one lobe, with only scattered infiltrations in the rest of the same or the opposite lung. They state that an important diagnostic point for the roentgenologist is displacement of the hilus on the side of the lesion. There it is drawn upward. Stein's¹⁴⁴ patient died of tuberculous meningitis, and the important feature of the case was the presence of a large cavity in the left lung which contained fluid filled with cholesterol crystals. The probability of a tuberculous pleurisy twenty-five years previously, prompts the author to theorize as to the etiologic connection between cholesterol-thorax and tuberculosis.

Tuberculous Lobitis.—Malugani¹⁴⁵ reports ten cases, nine of which were tuberculous lobitis and one upper right interlobar pleurisy, included for purposes of differentiation. He says the condition of tuberculous lobitis is rare, and varies with the type, which may be one of three. It may show: (1) homogeneous opacity; (2) non-homogeneous opacity, with a "bird's nest" or "bread crumb" aspect, or (3) non-homogeneous opacity, with a single zone of more normal clearness (cavity). He feels the diagnosis is relatively easy, because it is characterized by opacity of a whole lobe, with or without cavity formation, and a distinct outline following the interlobar fissure. It is relatively benign.

Surgical Tuberculosis.—Lambranzi¹⁴⁶ describes the roentgen picture of pulmonary tuberculosis in persons with surgical tuberculosis. It is evidenced in a typical fibrous condition which usually progresses slowly and especially in the early stages causes few or no characteristic symptoms. He believes that surgical tuberculosis has an immunity

effect which retards development of the lung infection.

Healing.—Anderson¹⁴⁷ and Fales¹⁴⁸ write timely reminders of the instability of apparent arrests in chronic tuberculous disease. From Beaudet's¹⁴⁹ report of six cases, he concludes that tuberculosis heals by absorption or by fibrosis, and that the former is by far the more common form of repair, as evidenced in the gradual clearing in serial roentgenograms. He believes that fibrosis can be, and frequently is, absorbed, and that therefore it is, to some extent, a stage in the healing process.

Cavities.—Saley's¹⁵⁰ analysis of tuberculous cavities and results of artificial pneumothorax therapy in 31 cases is a valuable one for the plithisiologist who uses that therapeutic device. His classification of cavities as to type conforms to that of Pinner and Parker,¹⁵¹ which is based essentially on the factor of fibrosis. They recognize three types: (1) moth-eaten areas in the infiltrated parenchyma; (2) round or oval cavities, and (3) fibrotic irregular cavities. Sweany, Cook, and Kegerreis¹⁵² report a statistical study of the position of primary cavities as determined by means of stereoscopic X-ray films. They found about 98 per cent of the cavities situated on bronchi that are directed rather sharply posteriorly, and the posterior aspect of the bronchi seemed to be the most important factor. Nearly all cavities were infraclavicular; the distribution of the lesions as to the side of the lung was directly proportional to the lung volume of the respective sides; the position of the cavities indicated a common factor of origin and suggested a bronchogenic origin, and the posterior subapical bronchial rami, the apical, horizontal and those of the apex of the lower lobe were

¹⁴⁴Arch. Int. Med., March, 1932, XLIX, 421.

¹⁴⁵Arch. di radiol., 1930, VI, 763.

¹⁴⁶Radiol. med., 1930, XVII, 1183.

¹⁴⁷U. S. Vet. Bur. Med. Bull., June, 1931, VII, 561.

¹⁴⁸Med. Bull. Vet. Admin., December, 1931, VII, 1121.

¹⁴⁹U. S. Vet. Bur. Med. Bull., July, 1931, VII, 643.

¹⁵⁰Am. Jour. Roentgenol. and Rad. Ther., February, 1931, XXV, 231.

¹⁵¹Am. Jour. Roentgenol. and Rad. Ther., April, 1931, XXV, 434.

¹⁵²Am. Rev. Tuberc., November, 1931, XXIV, 558.

understood. Loben,¹³⁰ believing that the roentgen diagnosis is probably superior to all other methods, distinguishes three main groups according to the roentgen appearance: (1) infiltrative processes and their localized sequences; (2) the disseminated forms; (3) ulcerative, cavernous, mostly exudative phthisis. He says that one cannot always classify a case, but he advises doing so as far as possible. Goldberg and Gasul¹³¹ cling to the term "epituberculosis," and under that title, they report a clinical and roentgenologic study of ten cases which they observed for over two years. Later,¹³² they report another case that was complete even to the autopsy findings which are rarely on record for this condition.

Relation to Skin Condition.—Dickey¹³³ reports eight cases (from the pediatric service of the Stanford Medical School), in which erythema nodosum was associated with tuberculous infection which was demonstrable in radiographs. He believes the skin condition bears very close relation to early tuberculous infection.

Miliary Tuberculosis.—Seven cases of miliary tuberculosis are reported—each because of a rare complication, peculiar manifestation, source of infection, type of treatment, or the fatal or healed termination. One of Stamm's¹³⁴ cases evidenced pulmonary tuberculous involvement and erythema nodosum, seeming to support Dickey's belief in the relation of the two conditions. In the case reported by Voron and Pizzera¹³⁵ the evidence seemed to indicate that the infection had been acquired *in utero*.

Pneumothorax Therapy.—Pneumothorax therapy in tuberculosis is constantly undergoing change and improvement. Adler¹³⁶ urges constant roentgen control; Poix and

Bosnieres¹³⁷ report an elaborate and seemingly effective method of administering it without hospitalization; Bader¹³⁸ calls attention to the danger of subsequent re-expansion after release if a fibrin coating has formed over the pulmonary pleura. Blechmann, Kindberg, and Cottentot¹³⁹ believe their patient is the youngest on whom pneumothorax has been attempted for pulmonary tuberculosis with cavity formation. It was performed at the age of five months, and at sixteen and one-half months the child's condition was excellent and the cavity no longer evident. Beal's¹⁴⁰ six cases of symptomless spontaneous pneumothorax were all discovered in the course of routine examination of patients who had pulmonary tuberculosis. In five of the cases, the diagnosis was confirmed roentgenologically; the other patient was too ill for the examination.

Correct Diagnosis.—Briskman¹⁴¹ calls attention to the possibility of confusing undulant fever and pulmonary tuberculosis. His report of two such cases which were sent to the Union Printers Home in Colorado Springs by mistake, motivates the warning. Frothingham,¹⁴² speaking before the National Tuberculosis Association, stresses the importance of obtaining a correct diagnosis between pulmonary tuberculosis and pulmonary or bronchial malignant neoplasms, because of the wide difference in methods of treatment. He gives an exhaustive discussion of 39 cases of primary pulmonary malignancies and 16 cases of secondary manifestations, and concludes that because of the similarity of pulmonary carcinoma and tuberculosis, the serial X-ray is the best aid to diagnosis. Kornblum and Ellison¹⁴³ report four cases of atypical pulmonary tuberculosis which, in the final stages of healing, presented certain difficul-

¹³⁰Med. Klin., May 22, 1931, XXVII, 763.

¹³¹Am. Jour. Med. Sci., December, 1930, CLXXX, 824.

¹³²Am. Rev. Tuberc., September, 1931, XXIV, 285.

¹³³Am. Jour. Med. Sci., October, 1930, CLXXX, 489.

¹³⁴Monatss. f. Kinderh., December, 1930, XLVIII, 497.

¹³⁵Bull. Soc. d'obst. et de gynéc., April, 1931, XX, 243.

¹³⁶Ztschr. f. Tuberk., May, 1931, LX, 434.

¹³⁷Presse méd., Nov. 8, 1930, XXXVIII, 1513.

¹³⁸Ztschr. f. Tuberk., July, 1931, LXI, 207.

¹³⁹Jour. Am. Med. Assn., May 16, 1931, XCVI, 1712.

¹⁴⁰British Jour. Tuberc., January, 1931, XXV, 21.

¹⁴¹Am. Rev. Tuberc., October, 1931, XXIV, 246.

¹⁴²Ibid., February, 1931, XXIII, 107.

¹⁴³Am. Jour. Roentgenol. and Rad. Ther., May, 1931, XXV, 620.

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¹³⁴Monatss. f. Kinderh., December, 1930, XLVIII, 497.

¹³⁵Bull. Soc. d'obst. et de gynéc., April, 1931, XX, 283.

¹³⁶Ztschr. f. Tuberk., May, 1931, LX, 434.

¹³⁷Presse méd., Nov. 8, 1930, XXXIII, 1313.

¹³⁸Ztschr. f. Tuberk., July, 1931, LXI, 267.

¹³⁹Jour. Am. Med. Assn., May 16, 1931, XCVI, 1712.

¹⁴⁰British Jour. Tuberc., January, 1931, XXV, 21.

¹⁴¹Am. Rev. Tuberc., October, 1931, XXIV, 236.

¹⁴²Ibid., February, 1931, XXIII, 107.

¹⁴³Am. Jour. Roentgenol. and Rad. Ther., May, 1931, XXV, 670.

pearance of the tubercle bacillus from the sputum. The last two had had phrenic exeresis previously. The authors believe the results were due to the combined effect of the two therapeutic measures.

Larynx.—Gelfon and Panow¹⁶⁴ used roentgenoscopy in the diagnosis of tuberculosis of the larynx in connection with the clinical and laryngoscopic findings to localize the process and show its extent and depth. Sylla¹⁶⁵ found certain peculiarities in the roentgenograms of 128 patients with pulmonary and laryngeal tuberculosis. These were of three types: (1) cavernous pulmonary tuberculosis, with a predominance of large foci disseminated over both lungs; (2) hematogenic dissemination, and (3) cirrhosis of the upper portion of the lung and peculiar dissemination in the lower lobes. He considers the etiology of these various conditions, and discusses the histologic examinations and the possible therapeutic means. Galland and Rautureau¹⁶⁶ describe the lesions they found in the lung roentgenograms of nine cases with tuberculous laryngitis. They found the lesions were diffuse, almost entirely bilateral, always localized in the upper portion of the lung fields, occasionally in the apices only. There was no invasion of the bases, but, in time, there was marked involvement of the parenchyma. They believe that primary tuberculous laryngitis does not exist, but that it is effected by the lymphatic route, by infection from the tracheobronchial, mediastinal, and cervical glands rather than by direct infection. An important roentgen finding is a finely disseminated, granular-like process developing in both apices, with retention of these characteristics throughout the course of the disease.

Sarcoid.—Michelson¹⁶⁷ reports a case of sarcoid in a girl 26 years old, in which there

was pulmonary involvement also. The skin lesions responded to X-ray therapy, but deep therapy over the lungs did not produce noticeably definite changes in the lung findings. In the article by Kirklin and Morton,¹⁶⁸ they discuss the subject fully, and state that "when Boeck's sarcoid occurs with visceral involvement, characteristic changes may be observed in roentgenograms of the bones and of the lungs." The latter show diffuse infiltration and mottling usually in the lower and middle portions.

Measles.—Mikulowski¹⁶⁹ calls attention to pneumonic phthisis of measles in infancy and its frequency.

Sinus Examination.—Osmond¹⁷⁰ reports five cases which prompt him to stress the importance of sinus examination in cases of questionable pulmonary tuberculosis or other chest infections.

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¹⁶⁴Beitr. z. Klin. d. Tuberk., Oct. 24, 1931, XCVII, 1263.

¹⁶⁵Deutsche Arch. f. Klin. Med., May 30, 1931, CLXX, 630.

¹⁶⁶Rev. de la Tuberc., January, 1931, XII, 25.

¹⁶⁷Deutsche med. Wchnschr., April 3, 1931, LVII, 574.

¹⁶⁸RADIOLOGY, March, 1931, XVI, 328.

¹⁶⁹Arch. de méd. des enf., December, 1930, XXXIII, 711.

¹⁷⁰Jour. Am. Med. Assn., Dec. 12, 1931, XCVII, 1778.

the only significant ones. Fales and Beaudet,¹⁵³ incited by the statement made by Pinner, (who was quoting Graeff) that the tuberculous cavity is the death sentence of its bearer, surveyed 120 cases of pulmonary tuberculosis with 147 cavities. They found that a surprisingly large number healed, that the ability of a cavity to heal depended upon its size and the amount of involvement, that therapeutically the rest treatment seemed of greater importance than surgical measures, and that the prognosis was not good if the cavitation was bilateral. Werner and O'Brien¹⁵⁴ summarize and tabulate their results on 200 cases of pulmonary tuberculosis with cavities three millimeters in diameter or larger. Their results are conditioned by important factors to which justice cannot be done in abstract, consequently the article should be studied in the original. Mitchell¹⁵⁵ discusses the annular shadows in the lungs (excluding ordinary tuberculous cavities) which are so puzzling to most radiologists. He calls them "air cysts," and believes that usually they represent air spaces in the lungs produced by perforation of a small bronchus, with escape of air into the connective tissues in the form of a single bubble. Rapid increase in size may result from a ball-valve action between the bronchus and the air space by allowing air to enter the "cyst." However, if the point of perforation is healed over, then there may be rapid absorption of the enclosed air and decrease in the size of the shadow. He believes these shadows are pathognomonic of tuberculosis even though pulmonary fibrosis is not evident.

Therapy.—From the published results of various investigators, ultra-violet radiation would seem to be of value in cases of catarrhal bronchitis or bronchitis of long stand-

ing, tuberculous adenitis, and pleuritis, skin and other superficial conditions. It is of questionable value in the treatment of pulmonary tuberculosis. Murray¹⁵⁶ found improvement in two of 26 cases, and Kettelcamp¹⁵⁷ noted some fibrosis in patients with pulmonary tuberculosis who were treated for tuberculous enteritis, but he feels that the significance is doubtful. In Sepke's¹⁵⁸ report of 400 cases from 1,600 which he has treated with a combination of ultra-violet and natural sunlight, he advises not radiating the more active types, especially the exudative forms. Mozdien¹⁵⁹ found that a combination of local X-ray therapy and general light exposure gave the best response in a number of patients with tuberculous glands. Schulte-Tigges¹⁶⁰ states that patients with productive pulmonary tuberculosis who are fever-free, or the cirrhotic cavernous types without elastic fibers in the sputum, may be given roentgentherapy, but that irradiation is contra-indicated in patients with fresh infiltrative or active exudative processes. Altschul and Schiller¹⁶¹ consider roentgentherapy indispensable as an auxiliary method in the treatment of surgical tuberculosis. Kaminsky and Davidson¹⁶² studied 16 persons and found that, judging from the roentgen evidence, the oral administration of small doses of irradiated ergosterol augmented the serum-calcium concentration of patients with pulmonary tuberculosis; but such increase did not seem to influence the degree of calcification of lung lesions to any appreciable extent. Trepiccioni and di Natale¹⁶³ used direct roentgentherapy in 14 cases of pulmonary tuberculosis: six cases showed "benefit," six showed "some," and two showed roentgen and clinical clearing of cavities and disap-

¹⁵³Arch. Phys. Ther., September, 1931, XII, 527

¹⁵⁴Med. Klin., May 22, 1931, XXVII, 771

¹⁵⁵Strahlentherapie, Jan. 31, 1931, XXXIX, 507

¹⁵⁶Schweiz. med. Wchnschr., April 25, 1931, LXI, 404

¹⁵⁷Strahlentherapie, 1931, XLI, 755

¹⁵⁸Am. Rev. Tuberc., October, 1931, XXIV, 493

¹⁵⁹Lotta Con la Tuberc., August, 1931, I, 842

¹⁵³Am. Rev. Tuberc., June, 1931, XXIII, 690

¹⁵⁴Am. Jour. Roentgenol. and Rad. Ther., December, 1930, XXIV, 620.

¹⁵⁵British Jour. Radiol., April, 1931, XVI, 602.

¹⁵⁶British Jour. Actinother. and Physiother., October, 1930, V, 135

PNEUMONIA, ROENTGENOLOGICALLY CONSIDERED

By A. G. SCHNACK, M.D., Queen's Hospital, HONOLULU, T. H.

IN spite of the great amount of experimental work done on the etiology of the various types of pneumonia, there is still a great deal of uncertainty and controversy concerning many of the basic factors entering into the development of acute lung consolidations. Until these controversial elements, which in great part deal with the mechanical factors of consolidations, are thoroughly understood, they will tend to produce confusion in diagnosis and therapy. I aim to present a few facts from recent experimental work which seem to explain the sequence of events in pneumonic consolidations, and to show how these facts can be utilized to a great degree in the diagnosis, and, to some extent, in judging the future course of a pneumonic infection.

A number of articles have recently appeared on experimental and pathologic atelectasis and its subsequent effects on the involved lung tissue. Coryllos and Birnbaum (1) have beautifully demonstrated the ease with which atelectasis of a desired lobe in a dog's lungs may be produced. They introduce, through a bronchoscope, a dilatable rubber bag, and make a study of the results of introducing different organisms to produce specific types of pneumonia. Their conclusion that pneumonia always begins with an atelectasis has much support from roentgenologic evidence. An abbreviated résumé of their remarks follows.

"Atelectasis and pneumonia have a common pathogenesis. Incomplete bronchial obstruction leads to emphysema. Complete bronchial obstruction interferes with the ventilation, circulation, and drainage of the involved lung, and atelectasis and cellulitis result. The degree of cellulitis depends upon the virulence of the infecting organism and the duration of the obstruction. Lobar and

lobular atelectases, with the resulting lobar and lobular pneumonia, are due to the occlusion of bronchi of different sizes by mucous exudate and bronchial mucosa edema. Whether we have a lobar or lobular atelectasis and pneumonia depends for the most part on the type of organism in the occluding exudate. Organisms producing much edema or thick exudate occlude larger bronchi.

"Type IV pneumococcus, present in the main bronchi of 80 per cent of people, is the most common organism causing bronchial edema and obstructing mucous exudate. Less viscid exudates, such as those produced by influenza, staphylococcus, and streptococcus, cause obstruction of smaller bronchi and bronchopneumonia. Abdominal operations, regardless of the type of anesthesia, due to stasis of bronchial secretion, posture, and splinting of the thorax, are apt to initiate bronchial obstruction. Absorption of the air results in atelectasis and subsequent pneumonia. Foreign bodies and bronchial tumors may do the same. The serum exudate, containing antitryptic ferments, continues to obstruct for several days. Between the fifth and eleventh days, the cellular exudate, through disintegration, liberates a proteolytic ferment which neutralizes the antitryptic ferments, whereupon digestion of the thick exudate suddenly releases the back pressure upon the involved lung tissue, allowing lung drainage to a greater or lesser degree. At this point, the so-called 'crisis' appears. Acidulating the bronchial secretion with carbon dioxide hastens the proteolytic action. Roentgentherapy through destruction of the white blood cells is credited with liberation of excess proteolytic ferment, and hastening the crisis and subsequent clearing process. (The sudden re-

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(Section on the Thorax, beginning with Tumors, to be continued.)

Plan High Voltages and Low Temperatures to Explore Interior of Atom.—Two new programs of research at Princeton University call for the development of apparatus capable of producing millions of volts of static electricity and a liquid hydrogen laboratory which will make possible temperatures around 400 degrees below zero Fahrenheit. By means of these extreme voltages and intensely low temperatures, it is hoped to learn more about the forces which hold atoms and molecules together in solid crystals and the laws governing the geometrical patterns of their arrangement.

More information concerning the forces which hold solids together is important commercially in determining and modifying the strength of materials for industry.

Prof. Rudolph Walter Ladenburg, who has been associated with the Kaiser Wilhelm Institut für Physikalische Chemie in Berlin, has been added to the faculty to take charge of these new fields of research. He succeeds Prof. Karl T. Compton, who resigned two years ago to become president of the Massachusetts Institute of Technology.—*Science Service.*

tasis involves a considerable portion of the lung, but the lung infection itself is still limited. Should our respiratory muscles be attempting to splint the chest wall against movement, we should expect to find them in a state of contraction. It would be difficult, except by elaborate investigation, to determine the tone of the intercostal muscles, but it should be easy to determine the state of contraction of the diaphragm by the shape of its upper contour.

A state of contraction (splinting) would manifest itself by a flattened, lowered dome, with a narrowing and flattening of the intercostal spaces. We find narrowed intercostal spaces, but the diaphragm on the affected side is generally high and sharply domed. In other words, the chest wall and diaphragm give the impression of being "sucked in." The heart, whether or not dilated from toxemia or pulmonary resistance, is often drawn to an appreciable degree to the affected side. The transverse diameter of the affected chest is generally less than that of the opposite side. If we cannot account for a high diaphragm and apparent lessened chest volume on the basis of old lung and pleural changes, eventration, or intra-abdominal pressure, we can judge the extent of lung collapse from the diminished chest volume. But we must remember that the left diaphragm is normally lower and somewhat more mobile than the right, and that air in the stomach and splenic flexure, large liver, subdiaphragmatic abscess, or abdominal masses, or distention, may displace a diaphragm upward. We can follow the daily increase in the lung density on our X-ray plates, remembering that the entire involved lobe may not, at any time, present a complete consolidation.

What determines the extent of this consolidation may depend upon more than the point of obstruction in the bronchus and the offending organism. The tissue reaction, which is, perhaps, very important, would



Fig 1-B Case 1 Film made on July 25, showing great consolidation of the right lung base and clear left chest

bring forth a consideration of all the elements of the body reactions to different types of organisms. The allergic phenomenon, from a non-specific viewpoint, should perhaps be considered in the exudative reaction. We are sure that certain bronchial obstructions do not lead to pneumonic consolidations.

One cannot but theorize on these cases until more evidence is brought forth to explain events. We have cases in which the roentgenologic evidence of pneumonic exudate is entirely insufficient either to locate or judge the extent of our lung involvement. But the roentgenologic evidence of atelectasis, such as the high diaphragm, the drawing over of the heart to the affected side, and the lessened chest volume on the affected side, all immediately make one fairly certain that we are dealing with an infected atelectatic lung, a pneumonia. Physical examination will generally confirm the contention.

In our consideration of high diaphragm, several facts must be noted. It has been shown that a very high percentage of post-operative cases, regardless of the type of



Fig. 1-A. Case 1. Film made on July 17 shows the right chest volume greatly reduced and the right diaphragm high. No lung clouding was apparent.

lease of the bronchial obstruction may be likened to the sudden drainage of a boil, which is quickly followed by subsidence of symptoms.) If the blockage is maintained, abscess or gangrene may result.

"Theories have been brought forward by Cutler and others to show that pneumonia is, in reality, due to embolism of the terminal arteries, but this is not borne out by findings, which show for the most part the arteries patent and ready to resume full function when the compressing exudate is released."

The roentgenologic findings all fit in much better with the atelectatic-origin theory of pneumonias. Certain roentgenologic findings are of value in predicting, to a certain extent, the lobes which will be involved before actual lung consolidation can be detected on the X-ray film. Lung lobes may be involved without visible consolidation in the plate but, by physical examination, give signs of consolidation. It is quite probable that atelectasis of lung tissue from bronchial obstruction need not go on to actual lung consolidation, or only to patchy areas of consolidation. Atelectasis of early infancy is generally not associated with pneumonic

consolidation, although the alveoli may be partly filled with exudate.

From the clinical side, on close scrutiny of individual cases, many varying observations may be made. The frank lobar pneumonias with sudden onset, giving almost from the start all the necessary earmarks of extensive consolidation, are in marked contrast to many of the lobular pneumonias. These are often preceded by an upper respiratory infection which, if the cough did not direct us to examine the chest closely, might pass undetected. We speak of central pneumonias (3) because we are unable to determine parenchymal consolidation. Diminished breath sounds and, a little later, râles are the only clues by which to estimate the significance of a rising temperature, rapid pulse, cough, etc. Atelectasis in its early states, with only a beginning cellulitis, can easily explain our findings upon physical examination. It is a remarkable fact that, during the early stages of a pneumonia, our roentgenographic evidence of consolidation may be practically *nil*. In some cases if we fail to take into consideration all the concomitant evidence, we may never definitely demonstrate the location of the involved lung. The exudate may be too faint to cause a definite roentgenographic shadow at any time during the lung involvement; again one may observe a small area of exudate grow from day to day on the roentgenographic plates. That a consolidated lung is generally apneumatic would, of course, explain immediately why it is smaller than the pneumatic lung as it usually exists in the chest.

It has been taken for granted that, with pneumonic infection, a special splinting of the chest wall near the infected area occurred. The fact that so much of the chest was restricted in its respiratory motion during the very early stages of pneumonia seemed to demand such an explanation. Our explanation is that the primary atelec-

tasis involves a considerable portion of the lung, but the lung infection itself is still limited. Should our respiratory muscles be attempting to splint the chest wall against movement, we should expect to find them in a state of contraction. It would be difficult, except by elaborate investigation, to determine the tone of the intercostal muscles, but it should be easy to determine the state of contraction of the diaphragm by the shape of its upper contour.

A state of contraction (splinting) would manifest itself by a flattened, lowered dome, with a narrowing and flattening of the intercostal spaces. We find narrowed intercostal spaces, but the diaphragm on the affected side is generally high and sharply domed. In other words, the chest wall and diaphragm give the impression of being "sucked in." The heart, whether or not dilated from toxemia or pulmonary resistance, is often drawn to an appreciable degree to the affected side. The transverse diameter of the affected chest is generally less than that of the opposite side. If we cannot account for a high diaphragm and apparent lessened chest volume on the basis of old lung and pleural changes, eventration, or intra-abdominal pressure, we can judge the extent of lung collapse from the diminished chest volume. But we must remember that the left diaphragm is normally lower and somewhat more mobile than the right, and that air in the stomach and splenic flexure, large liver, subdiaphragmatic abscess, or abdominal masses, or distention, may displace a diaphragm upward. We can follow the daily increase in the lung density on our X-ray plates, remembering that the entire involved lobe may not, at any time, present a complete consolidation.

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Fig. 1-B. Case 1. Film made on July 25, showing great consolidation of the right lung base and clear left chest.

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In our consideration of high diaphragm, several facts must be noted. It has been shown that a very high percentage of post-operative cases, regardless of the type of



Fig. 2. Case 2. There was little lung involvement and little change in the position of the diaphragm.

operation, show some elevation of one or both diaphragms, usually more on the right side, and most of these are not associated with pneumonic consolidation. Just what proportion of these are due to bronchial obstruction it is hard to state (2). Many consider the condition a partial paralysis of the diaphragm, possibly due to trauma, morphine, toxins, etc. It is, therefore, apparent that a careful consideration of all facts is in order in each case.

A double lung exposure may be made on the same plate, having the patient hold his breath, first in deep inspiration and then in expiration for two exposures. For technical reasons, the exposure during expiration should be of the full chest while the second is only one-half of the normal chest exposure. These will show a decided limit to the diaphragmatic excursion on the affected side. Fluoroscopy, when possible, is a valuable aid. All clinical evidence must be considered in the roentgenologic interpretation.

Here in the semi-tropics, with our uniform climate, pneumonias seem to offer greater diagnostic difficulties than in colder

climates. The symptoms may be few and physical findings very uncertain. Cases presenting symptoms of pain and tenderness in the abdomen may be easily misinterpreted, and it is sometimes a question if the so-called post-operative pneumonia was not, in reality, the primary difficulty. In the past it is quite likely that the lack of definite lung clouding in the roentgenographic film in certain cases of atelectasis, which had not developed into full-blown pneumonias, might have led to numerous errors in diagnosis. Our local experience seems to point to the occurrence of such cases in definite series, although our simpler laboratory findings do not indicate that we are dealing with any special infecting organism. Some of the cases have not at any time shown definite clouding in the roentgenographic plate, in spite of the typical clinical picture of pneumonia. It behooves us to consider carefully our indirect roentgenographic evidence of our early pneumonias or the forerunner atelectasis before pronouncing a chest roentgenograph negative. Close attention to clinical findings and other data is most important in the consideration of a doubtful chest.

In the development of pneumonia (3), consolidation extends from the lung periphery toward the hilum, with the base of the triangle at the pleura. This in no way discredits the theories just presented. The pre-consolidation period shows, perhaps, a slight blurring and thickening of the usual markings of the atelectatic lung, but this cannot be detected with certainty. When atelectasis sets in, the usual triangular radiation of lung markings will present a narrowing of the triangle or even a paralleling of the striations. This may give valuable information as to which lung lobe is predestined to consolidation.

Complete bronchial obstruction leads early to partial instead of complete atelectasis, as complete absorption of nitrogen is a very

slow process, which varies with the conditions in the affected lung. This frequently prevents the recognition of the lung collapse from increased lung density alone. With patent bronchi, lung collapse from pneumothorax is often more complete and is easily recognized from increased lung density. This is, however, quite a different condition.

As is exemplified by the cases quoted, we may find roentgenographic evidence of atelectasis only, with the subsequent development of lung plate clouding. We may also have evidence of atelectasis without subsequent lung clouding. In such cases, indirect evidence, substantiated by clinical findings, must be the guide in the interpretation of the chest plate.

Case 1. W. B., male, Portuguese-American, age 21 years, entered Queen's Hospital on July 15, 1931. Nine days before entrance, the patient had begun to complain of generalized aches and pains. He had had severe sweats for four days, but no cough. Physical examination revealed râles at both bases, with hyper-resonance and increased breath sounds at the left base. The diagnosis was pneumonia of the left base.

On July 16, examination of the right base revealed dullness and + V.R.; breath sounds were absent. Râles were heard in the left base. The man, who complained of pain in the right chest, produced typical rusty sputum. Diagnosis was right base pneumonia. The consultant at this time thought both bases were pneumonic.

On July 17 the blood count was 10,050 white blood cells, 72 per cent polymorphonuclears, 26 per cent small lymphocytes.

Direct stain of the sputum showed many pus cells and many Gram-cocci in pairs, a few in chains, some lancet-shaped. Culture of the washed sputum showed numerous minute non-hemolytic green-producing colonies, and Gram-cocci in pairs and short chains.

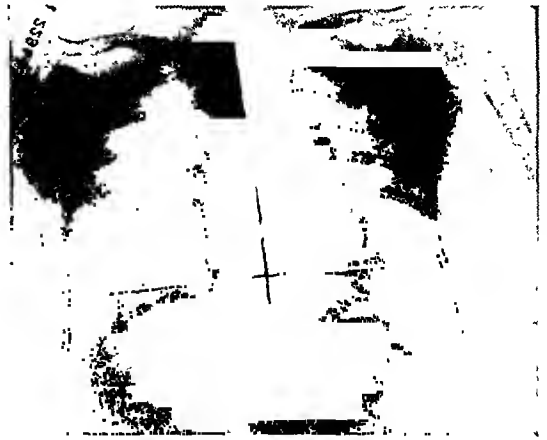


Fig. 3. Case 3. Film made in semi-prone position. Note the elevation of the right diaphragm and dilatation of the heart.

On July 22 the white blood count was 12,500, polymorphonuclears, 78 per cent, small lymphocytes, 20 per cent.

The temperature, which on admission was 100° (respiration 34 - 44) continued moderately high to July 27, then remaining normal, or subnormal, with increased pulse rate.

Discussion.—This is a case that illustrates perhaps most clearly what I am trying to prove. The fever, rapid pulse, and respiration, rusty sputum, chest pain, indicated a pneumonia which had not been accurately localized clinically. Without any information except that a pneumonia was suspected, a chest plate, on July 17, with the patient lying almost flat on his back led us to an interesting conclusion. The right chest volume was greatly reduced as compared with the left. The right diaphragm was high. No lung clouding was made out. We were able to report, however, that, although there was no lung clouding seen in the plate, an atelectasis of the right lower lobe was a good probability and that apparently there was developing a right basal lobar pneumonia. The considerable degree of chest collapse indicated also that a large lobe was involved. (This generally means the right lower lobe.) The correctness of

the assumption was proven by the second plate (July 25), which showed a great consolidation of the right lung base and a clear left chest.

Case 2. Mrs. R. K., age 31 years, white. This case illustrates the condition of small lung involvement with very little change in the position of the diaphragm, and very little diminution of chest volume (right middle lobe).

Case 3. K. A., female, age 12 years. The patient presented a typical clinical picture of severe pneumonia. The temperature rose abruptly to 104° and subsided by crisis on the fifth day. The white blood cells were as high as 34,000 with 92 per cent polymorphonuclears. The respiration was 40. The physical examination showed enough evidence to indicate definitely a pneumonia of the right lung base.

The X-ray (portable) film was taken three days after admission, when the patient was semi-prone. While admitting a slight

over-exposure here, one cannot but be impressed by lack of the usual findings of pneumonic clouding. The elevation of the right diaphragm and the "toxic" dilatation of the heart are, from the roentgenologist's viewpoint, our only evidence of a possible pneumonia. A second plate, taken three days later, did not show any definite clouding.

This illustrates one of several cases in which, at no time, could a pneumonia be diagnosed from lung clouding in the plate.

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Carbonic Acid Cause of Earth's Ice Age.—If the amount of carbonic acid in the air decreased to a half of its present amount, the temperature would fall enough to cause another great ice age on the earth. Calculations showing this were disclosed to the National Academy of Sciences by Dr. E. O. Hulburt, of the United States Naval Research Laboratory.

The small amount of carbon dioxide in the air absorbs much of the heat of the sunlight falling on the earth's surface. A change in the amount of this gas changes markedly the amount of heat retained by the air and, therefore, the average temperature over the earth's surface. Dr. H. B. Maris, also of the Naval

Research Laboratory, originated the new theory.

Dr. Hulburt's work was concerned in the first place with calculating the air temperature to be expected from a knowledge of the kinds and amounts of different gases present in the atmosphere at different heights and from a knowledge of how the various constituents of sunlight are absorbed by these substances. The sea level temperature calculated from Dr. Hulburt's formula comes within one degree of the known average earth temperature. This is taken to mean that emission and absorption of radiation are the only processes concerned in the control of the earth's atmospheric heat on the surface. At higher levels mixing by winds interferes with simple conclusions of the theory.—*Science Service.*

HORIZONS IN RADIOTHERAPY

By HERBERT HOFMANN, M.D., BUENOS AIRES, ARGENTINA

THE superiority of the gamma radiations of radium in their biologic action, and in their application in the treatment of neoplasms, is well known. Radiotherapeutic apparatus of increasing potentialities and efficiency is constructed for the purpose of attaining as closely as possible the wave length of the gamma rays of radium, and consequently utilizing their physical qualities and biologic effects. The present advances in electric engineering have practically solved the problem of obtaining highly efficient electric apparatus; equipment yielding much more than 600 K.V., with 20 ma., has been tried out and found to satisfy the most exacting demands. But the development of the manufacture of tubes used as X-ray sources has not kept pace with that of other apparatus, and, in daily practice (apart from the experimental field), tubes that will stand more than 400 K.V. cannot be used. Above these limits the life of the tube becomes problematic, and such tubes do not find practical application in radiotherapy.

Indeed, if we observe closely the results obtained with rays having a shorter wave length, we unfortunately have the painful experience of learning that irradiations produced in this way do not agree in any respect with the expectation of attaining a radiation which should be similar in its biologic action to that of radium.

With reference to the topography, localization, and nature of neoplasms, without considering the advantages of the application of radium, without discussing the different biologic values of radiations having different wave lengths, or the amounts of energy administered in the various forms and systems of application, without evaluat-

ing their power of penetration and their density, without making any comparison between radium and X-ray radiations, I wish to make the following statement: everyone knows, and the fact cannot be doubted, that the advantages to be derived from the use of X-rays, if their biologic value were as high as that of radium, would be, in addition to greater economy from the viewpoint of their cost, a greater penetration, followed by a wider field of application. Also, with the resulting advantages, it would be more feasible to irradiate larger regions, reaching a greater depth in the action of irradiation.

But, omitting all these considerations, which, relatively, may be possible, and absolutely avoiding even the mention of the immense scope of such a theme, I shall limit myself to the following reflections, so that later on experience may show the error or the exactness of the assertion.

It cannot be doubted that irradiations of catabiotic and consequently of oncolytic power, which are more pronounced, are *soft* radiations (alpha and beta rays). *Soft* radiations can be administered (except in combination with surgery) only superficially, for two essential reasons: (1) their power of penetration is extremely weak, and they are rapidly absorbed by the tissues upon which they fall; (2) before they succeed in acting on the tumor¹ there is produced too intense a catabiotic action on the superficial tissues for their application to be of value in practice. It is principally for these reasons (insufficient penetration and early or late necrosis of the skin) that attempts have been made to obtain increasingly penetrating radiations with X-rays. These rays, which are called hard rays, have, besides the greater depth of their action, owing to their superior penetrative power, a much more

¹ refer to neoformations that are non cutaneous and not surgically exteriorized.

marked cutaneous tolerance. By proceeding to the irradiation through various entries, one succeeds in obtaining, at a given point, situated deep down, or wherever it is desired to localize it, the summation of the doses administered, the skin remaining unimpaired. Now, the absorption of rays by the tissues is much less when the hardness of the rays increases. I shall not stop to analyze the various special methods of deep radiotherapy, the advantages and theories of which I omit. I shall discuss what follows from practice: experience has taught us that the biologic value of ultra-hard X-rays is greatly inferior, and that the results of their application are in no way the results expected at the beginning; or, at least, they are not the ones that were to be expected.

An ideal solution would be to make use of the advantages of soft rays from the catabiotic viewpoint, and to use hard rays for the necessary penetration and for keeping the superficial tissues intact. Indeed, the most practical thing is to avail oneself of hard rays (which are penetrating and do not attack the tissues in certain limits and degrees), which, locally, in a given and limited place, become transformed into soft ones, having a high catabiotic value, weak penetrative power, and great absorption.

The question of penetrability is solved with compression and high potentials. Recently an attempt has been made to increase the total mass of the dose employed by shortening the distance between the focus and the skin (Chaoul) in given conditions of protection against high potentials. We consider the problem of potentials solved, but the problem of dosage of radiation varies (Regaud). But the question of the efficacy of a radiation, the biologic value of ultra-hard radiations, is unfortunately less so, as is proved by daily experience. I repeat, then, that the ideal thing would be locally to obtain rays that were soft, the action of which was strictly limited and localized in the tissue which one desired to irradiate,

without injuring the other tissues, and keeping the cutaneous integuments intact.

The solution is to use the well-known principle of dissipation of energy. We shall use ultra-penetrating rays until the tissue in question is reached, thus being able to avail ourselves of the maximum of energy that is feasible, and completely protecting the tissues traversed by these rays. On reaching the tumor, these hard rays become transformed into soft ones, owing to secondary radiation and characteristic radiation. For that reason we have placed metalloid or metallic substances of varying physical conditions within the tumor. That is, depending on the organ treated, we fill the cavity with a metallic or metalloid solution, or else we place inside of it pieces, bars, needles, discs, moulds, etc., made of various substances. Thus we can fill the cavity of the uterus with iodinated oil, or infiltrate it with colloidal metals, or insert bougies of charcoal or different metals into it. In the case of the thyroid gland (carcinoma, adenoma, or Basedow morbus), we can place from 10 to 20 needles parallel by transfixion, needles of platinum or silver, gold, tungsten, and so on; or else we can infiltrate it with colloidal silver. The bladder may be filled with a metallic or metalloid suspension of Cu, Bi, Ca, C, with colloidal iron, and so on. The technic and the various systems vary infinitely with respect to the organ, the location, the type of tumor, etc. *In situ* we produce secondary rays, soft ones, which originate within the tumor itself, which are absorbed to a maximal extent, and whose biologic value is superior, having besides a penetration completely limited to the place whence they originate; they thus combine, as it were, the ideal conditions for the technic of radiotherapy. Not only are the secondary rays soft, but also their hardness depends on the substance employed (Ca, Au, Ag, Pb, Bi, C, Cu, Fe, Pt, Io, etc.); moreover, we may aspire to succeed in determin-

ing and proportioning the hardness of the secondary and characteristic rays. Thus we have *in situ* an X-ray tube, the rays of which have a short trajectory. Now, the hardness of the secondary rays depends not only on the substance employed but also on the tissue within which the rays originate, on the distance between the focus of the tube and the skin, on the degree of compression, and on the hardness of the primary rays. All these complex factors, the constants and the laws that govern their appearance, must be determined by experiment. The hypophysis may be infiltrated through the sphenoid, to be irradiated then with much greater efficacy than if the ordinary methods had been used. Thus we have a combination of the advantages of hard rays which do not greatly injure the tissues traversed, and the softer local oncolytic rays, localized in a topographic extension determined by the fraction affected, and having a short trajectory

and maximum absorptivity; in addition, we have the future optional dosage of the degree of hardness of the radiation and of the local electivity for tissues.

With respect to the technic to be used, it is so variable and the aspects of the variations are so different according to the organ, the localization of the disease, and the substance to use, that it is impossible to describe a definite method free from the individual criterion of the radiotherapist. Furthermore, because there are infinite variations, it is necessary to test even which of the substances are most indicated (Ca, C, Cu, Bi, Fe, Ag, Au, Pt, Io, Al, Pb), and in what physical state they should be used, whether in solution, oil suspension, liquids, bars, needles, or simply in powder wrapped in a small rubber sack, or contained in sounds or catheters.

The future and experiment will give their verdict on the horizons of radiotherapy.

New Source of Radium.—A new source of radium that is expected to break the Belgian monopoly is reported to be in process of development on the shores of Great Bear Lake near the Arctic Circle. Gilbert LaBine, Canadian mining engineer, explored the region by airplane and discovered a black rock which he thought might be pitchblende. Tests at the University of Alberta proved that the ore contained from 100 to 200 mg. of radium to the ton—as much as the best ores in the Belgian

Congo. The Canadian deposits are concentrated and easily accessible to the surface, which is not true of those in Africa. Before the development of the Belgian radium in 1922, the United States was producing the bulk of the world's supply from ores found in Colorado and Utah, but the working was discontinued as a result of the Belgian competition. There is at present less than a pound and a half of radium in the world, valued at \$70,000 a gram.—*Reprinted from Jour. Am. Med. Assn., May 7, 1932, XCVIII, 1668.*

MEDICO-LEGAL DEPARTMENT

REPRINTS SELECTED BY I. S. TROSTLER, M.D., CHICAGO

AN "ACCIDENT" OR "ACCIDENTAL"

Lickleider vs. Iowa State Travelling Men's Association (Ia.), 166 N.W.R. 363

The Supreme Court of Iowa says that one thing at least is well settled: The words "accident" and "accidental" have never acquired any technical meaning in law, and when used in an insurance contract they are to be construed and considered according to the common speech and common usage of people generally. Hundreds of attempts have been made by the courts to define these words in other terms, and while some of them may be regarded as helpful so far as they adhere to popular usage, others have served only to confuse the situation, if not, in fact, grossly to mislead. Certain it is that no attempt in this direction is in any respect an improvement on the definition found in our standard lexicons. It is: "An event from an unknown cause or an unexpected event from a known cause; a thing done or disaster caused without design or intention; an unusual and unexpected result attending the performance of a usual or necessary act."

There is, however, another alleged definition which has had a degree of judicial sanction which ought not to be passed without notice. According to this definition, an injury happening to an insured person through his own voluntary act is not an accident, nor is his hurt to be attributed to accidental means—a proposition that is wholly at variance with every statement of the true rule. It may be, and it is true, that if the insured does a voluntary act, the natural, usual, and to be expected result of which is to bring injury on himself, then death so occurring is not an accident in any sense of the word, legal or colloquial, and it is only when thus

limited that the rule so stated has any proper application. It makes no difference whether the injured man or some other person voluntarily sets in motion the first of a series of events which in connected line of causation results in his injury or death. If the resulting injury and violence to him "unexpectedly took place," or was "an unexpected result from a known cause," or was produced "without design or intention," or was "an unusual and unexpected result attending the performance of a usual or necessary act," or was an "event happening without the concurrence of the will of the person by whose agency it was caused," or if it was "caused or produced without design," it falls directly within the letter and spirit of the definition that has been placed on the words by the most competent lexicographers as well as by our most eminent jurists who have given the matter attention.

In this case a holder of a policy or certificate of accident insurance issued by the defendant, in attempting to remove an automobile tire which for some reason resisted his efforts, knelt on one knee, took hold of the casing with both hands, pulling and jerking at it for some time, when it came off with a snap and such suddenness as to cause him to slip or stagger back with the tire in his hands. He immediately turned pale, complained of being very ill, put his hand to his head, and lay down on the ground. Help was called, but he died about an hour later. A postmortem examination was made of the body by three physicians, who found that the immediate cause of death was a blood clot in the right coronary artery near the heart. Two of the physicians attributed the death to arteriosclerosis, while the third found no more arteriosclerosis than is usual

with a man of such size and age. The court holds that a case was made on which the plaintiff was entitled to go to the jury, and that it was error to direct a verdict for the defendant. If the arteries of the insured were sclerotic, but the sclerosis was only such as is the natural or usual accompaniment of increasing years, the fact, if it was a fact, that a bodily injury sustained by him would more likely be fatal than would be the case if such condition did not exist would not prevent a recovery on the policy should it otherwise appear that the injury was of the nature or kind described in the contract.

STATUTE OF LIMITATION: BARRING OF
ACTION FOR ROENTGEN-RAY INJURY

Ogg vs. Robb (Ia.), 162 N.W.R. 217

The Supreme Court of Iowa affirms a judgment in favor of the defendant that the plaintiff's alleged cause of action was barred by the statute of limitations. The court says it was alleged that in 1901 the plaintiff, then under 17 years of age, broke his right wrist. In July of that year, the defendant called the plaintiff into his office, without the knowledge or consent of the plaintiff's parents, and experimented on him with a roentgen-ray machine to secure films of his hand and wrist. That the defendant continued for ten days in said experiments, and used the roentgen-ray machine on the plaintiff's hand and wrist many times and made long and close exposures. That as a result the skin on the hand and wrist became discolored. That the defendant then informed the plaintiff and his parents that the use of the roentgen-ray machine caused such discoloration, and then falsely and fraudulently informed them that this discoloration was of no particular consequence and would be temporary in its effects, fraudulently concealing from them the true effect of radio-exposure produced by the roentgen-ray machine. That the defendant then treated

the discoloration for a time and it apparently disappeared, leaving a scar, but with the usual use of the hand. That the plaintiff and his parents fully relied on the statement and advice of the defendant as to the temporary effect of the roentgen rays, and nothing further was done in regard thereto until 1912. That the use of said machine by the defendant produced a cancerous condition which was latent until 1912, and the plaintiff had no knowledge of said condition until then. That then the tissues of the right hand where the roentgen rays had been applied broke down and became an epithelioma or malignant cancerous growth, which caused great pain and necessitated the amputation of the right forearm. Was the plaintiff's cause of action concealed by the statement of the defendant that the original burning was but temporary and was of no particular consequence, and that the defendant fraudulently concealed the true effect produced by the use of the roentgen-ray machine? The plaintiff alleged that he was burned in 1901 and, as he alleged, by the negligence of the defendant. This fact was known to the plaintiff and his parents. All damages which subsequently developed were traceable to and based on that act. By the original act the plaintiff was injured, and, as the petition alleged, by the negligence of the defendant. He would have been entitled to some damages at that time; and, if it be true that cancer necessarily and in all cases is the result of such burning, or if cancer is the probable result, such fact could be shown as bearing on the question of damages in an action for the original injury. If cancer is not the necessary or probable result of such burning, then the defendant's statement would be more or less of an opinion, and in that case the fact that later and in 1912 a cancerous condition did develop and the plaintiff's damages might thereby be increased, would not constitute a new cause of action. It would seem then that the plain-

s cause of action accrued at the time of original injury.

ROENTGENOGRAPHS IN BOOK AS EVIDENCE

Chicago, R. I. & G. Ry. Co. *vs.* Smith
(Tex.), 197 S.W.R. 614

The Court of Civil Appeals of Texas, in giving a judgment for \$10,000 damages for personal injuries, in favor of plaintiff, holds that there was no error in permitting the plaintiff to introduce in evidence, in connection with the testimony of a physician, certain "roentgenographic pictures" of the bones of the normal foot found in the medical work known as "Treatment of Fractures," by Scudder. The court says that on cross-examination of the physician he admitted that the plates or photographs introduced were to his knowledge correct pictures of normal arches of the feet. He further testified that the book containing the plates was a standard work, accepted by the medical profession generally. It further appeared from the record that the condition of plaintiff's feet, both before and after the injury, was shown by the evidence. In this part of the record, the plates were certainly immaterial or irrelevant. Their correctness was established by the evidence of the physician, and, while the predicate for their introduction in evidence was not laid prior to their introduction, this objection was removed by proper subsequent proof.

On the witness stand the plaintiff stated that the condition of his foot "affected his gait, the way being that he got awfully lame at times, when he saw that he could not

do as he used to do, and get about as he would like to, and hold the positions that he would want to." It was contended that if he was correct in his statement that his attacks of "blues" and his occasional morbid mental conditions were due to the injury to his feet, still such effects of an injury could not form the basis of a recovery, or enter into the estimate of the damages, according to the rule which prevails in the United States courts. But the court does not agree with that contention. It says that some of the lower federal courts have held that mortification or distress of mind from the contemplation of one's crippled condition, and its effect on the esteem of one's fellows, which is held to be mental pain, separable from the physical suffering caused by the injury, is too remote, indefinite, and intangible to constitute an element of damages in such case. But the statement of the plaintiff clearly did not bring this case within that rule. He made no reference whatever to the esteem his fellows would place on him, or to the mortification attending the realization of the fact that he was maimed, crippled, and disfigured, but stated that his mental condition, which he described as "the blues," was the result of the thought that he could not, since the accident, "get about" and do as he would like to, and hold the positions which he would want to hold. As an element of damages this came within the rule announced in the case of *M., K. & T. Ry. Co. vs. Miller*, 25 Tex. Civ. App. 460, 61 S.W. 978, in which a writ of error was denied by the Supreme Court of Texas.

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EDITORIAL

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THE ETIOLOGY OF OSTEITIS FIBROSA CYSTICA

One of the intriguing features of medicine is its ever changing horizon. The etiology of more and more diseases is becoming apparent as the gaps in our accumulated knowledge are bridged. A little over a quarter of a century ago, the first accurate description of osteitis fibrosa cystica was given by von Recklinghausen. Within the past few years, work has been done which has apparently demonstrated its etiology to be of an endocrine nature. This discovery has been prefaced, as usual, by the disclosure of a number of findings by independent workers, which dovetail so that the chain of events would seem to be complete.

The first important event in the solution of this problem took place in 1904, when Askanazy described a case of osteitis fibrosa cystica associated with a parathyroid tumor. Erdheim, in 1907, found parathyroid enlargement in three cases of osteomalacia, but he felt that the parathyroid enlargement was the effect, and not the cause, of the disease. In 1915, Schlagenhauser proposed the extirpation of the parathyroid tumor in cases of generalized osteitis fibrosa cystica, but it remained for Mandl to operate upon the first patient in 1926. It is of interest to note that he first transplanted additional parathyroids into the patient, and, upon observing a distinct increase in the severity of the symptoms, he removed the transplanted

material and a tumor from the parathyroids in the neck. Great clinical improvement followed this operation. In 1925, Hoffheinz reported a very significant study in which he found that, out of 45 cases of parathyroid enlargement recorded in the literature, 27 were associated with bone disease. Of these, 17 were complicated by osteitis fibrosa cystica, eight by osteomalacia, and two by rickets.

In 1925, Collip isolated the active principle of the parathyroid gland (parathormone). Injection of this extract was then shown to elevate markedly the blood serum calcium and to lower the blood phosphorus. The urinary excretion of calcium is also increased many times over the normal. The physiologic effect of parathormone is that of a mobilizer of the blood serum calcium. The work of Hunter and Aub contains ample proof that the source of this mobilized calcium is bone.

From the experimental side, Jaffe, Bodansky, and Blair have recently studied the effects of the administration of parathormone on guinea pigs. By the administration of large doses, they produced destructive lesions in the bone marrow cavity and, if these were severe enough to produce disturbances in the circulation, cyst formation resulted. The authors concluded that these were similar to osteitis fibrosa cystica in man.

The clinical test, applied by parathyroidectomy, has now been made many times, as shown by the reports of Mandl, Hunter and Turnbull, Snapper, Ballin and Morse, Barr and Bulger, and many others. In most cases there was clinical improvement with lowering of the blood calcium. In a number, there was complete or part recalcifica-

ion of the bone lesions; but, in some, the bone changes did not parallel the clinical improvement.

It is important to note that the clinical manifestations of hyperparathyroidism are present only in cases of generalized osteitis fibrosa cystica, while, in the localized type, the figures for the blood calcium and phosphorus are usually normal. Ballin and Morse feel that Paget's disease should be included in the hyperparathyroid syndrome, but many authors, such as Hunter and Schmorl, question this. A number of other bone diseases, having osteoporosis as a characteristic, are mentioned as belonging to this syndrome, but the classification of them awaits more complete chemical and clinical data.

In going over the sequence of events in this story, we find that osteitis fibrosa cystica was described in 1891 by von Recklinghausen. No etiologic lead was obtained until 1904, when a case was found at autopsy associated with a parathyroid tumor. This apparently went unnoticed until 1907, when three cases of osteomalacia, with parathyroid enlargement, were found. It was not until 1915 that it was first proposed that parathyroidectomy should be done in these cases, and 11 more years elapsed before the first case was operated upon (1926). A little earlier (1925) the active principle of the parathyroid glands was discovered. This has made it possible to determine the clinical criteria of hyperparathyroidism and to produce the disease experimentally in animals. Since that time surgeons all over the world have removed the parathyroids in many cases with good results.

Thus it is seen that an association of lesions first found at the autopsy table has been proven by surgical and chemical means to be cause and effect.

HOWARD P. DOUB, M.D.

Henry Ford Hospital
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ANNOUNCEMENTS

CONFERENCE ON BONE DISEASES

Dr. Joseph C. Bloodgood has sent us the following program of the Bone Demonstration to be conducted in September at the Surgical Pathological Laboratory, Johns Hopkins Hospital.

Monday, September 19.—The morning and afternoon will be devoted to X-ray studies of the teeth and the upper and lower jaws. Oral surgeons interested in the diagnosis of lesions in the region of the jaws are especially invited, whether they belong to the medical or to the dental profession.

Tuesday, September 20.—Conference (free) of members of the medical and dental professions who bring rare tumors, or tumors difficult to diagnose.

Wednesday, Thursday, Friday, September 21, 22, 23.—Diagnostic demonstrations.

The Editor is repeating this announcement, which appeared in the August issue, because this Conference promises to be of especial value to oral surgeons, orthodontists, and all roentgenologists who do any oral work—and we all do.

Anyone wishing to demonstrate a case should write to C. F. Geschickter, M.D., Surgical Pathological Laboratory, Johns Hopkins Hospital, Baltimore, Md.

NEW TUMOR CLINIC

The new Tumor Clinic Department of the Shreveport (Louisiana) Charity Hospital was recently opened. The unit, which is said to be unexcelled in the South, is equipped with a modern valve tube, 280,000-volt, 30-milliampere deep therapy machine and a shock-proof superficial therapy stand. One hundred and fifty milligrams of radium, distributed in fifty-three platinum and monel needles with accessories, a modern radium work bench with protective booth, a modification of Holfelder's field selector for the charting of patients for deep therapy,

and a complete clinical photographic department, all go to make it the equal of any clinic. Two special pavilions have been provided for housing the patients.

E. L. Sanderson, M.D., Superintendent of the Hospital, is Director and surgeon of the group. O. C. Rigby, M.D., gynecology; I. B. Rougon, M.D., urology; W. S. Kerlin, M.D., medicine; Guy A. Caldwell, M.D., orthopedics; P. R. Gilmer, M.D., chest; Dean Duncan, M.D., neurology; J. D. Woolworth, M.D., eye; L. W. Gorton, M.D., nose and throat; C. B. Erickson, M.D., dermatology; J. R. Matthews, M.D., pathology, and Harold G. F. Edwards, M.D., radiology, complete the group.

BOOK REVIEWS

LEHRBUCH DER RÖNTGENDIAGNOSTIK. By H. R. SCHINZ, W. BAENSCH, and E. FRIEDL. Third Edition; 1,623 pages, with 2,250 illustrations (cuts) and numerous tables. Published by Georg Thieme, Leipzig, Germany, 1931. Price, 220 marks.

The third edition of this excellent text-book on roentgen diagnosis has been entirely rewritten and revised, 492 pages and 655 illustrations have been added, and the present edition is now published in two volumes. Volume I, consisting of 704 pages, is devoted entirely to the skeletal system and without question constitutes the most comprehensive consideration of the subject available. Volume II is devoted to the other systems of the body. Both sections have been adequately rewritten to include all modern improvements in technic and diagnosis.

This book has become a virtual encyclopedia of roentgenologic diagnosis and as a work of reference is unequalled. The bibliography is unusually complete and includes the significant American literature as well as the foreign. It is unfortunate that the use of this text is limited to those who read German. An English translation would be a most valuable contribution to our literature.

JOHN D. CAMP, M.D.

TUBERCULOSE OSSEUSE ET OSTÉO-ARTICULAIRE.

By ETIENNE SORREL, Chirurgien de l'Hôpital Trousseau, Ancien chirurgien en chef de l'Hôpital Maritime de Berck, and MME. SORREL-DEJERINE, Ancien interne des Hôpitaux de Paris. Two volumes of 514 pages and 640 illustrations. Published by Masson et Cie, Paris, 1932. Price, 380 francs.

This two-volume atlas of the roentgenographic changes in tuberculosis of bones and joints is the result of many years of observation by the authors at the Maritime Hospital at Berck Plage sur Mer. As the authors state, this hospital furnishes a large amount of material which may be observed over a long period of time under nearly ideal conditions so far as laboratory studies, roentgenographic observations, and surgical treatment are concerned. The material has been compiled from a study of nearly ten thousand case records, from which the authors have selected examples of the various forms of tuberculous infection. Emphasis has been placed on the types most frequently seen although all forms are included.

Under each subject there is a systematic discussion of the etiology, pathologic anatomy (especially as regards the roentgenographic appearance), symptomatology, diagnosis, and treatment. The illustrations include not only extensive roentgenologic studies but in many instances actual photographs of the patient before and after treatment. These illustrations are well reproduced, the roentgenograms being particularly good in most instances. In many cases diagrammatic sketches of the roentgenograms are furnished. There are some photographs of pathologic specimens but no photomicrographs. To some of us, this omission seems a mistake. While the histologic pathology of tuberculous disease of bones and joints is well known, many cases have been reported as tuberculosis without proof. We do not doubt the authors' diagnoses, but for those of a skeptical nature an occasional photomicrograph would be worth while. Several cases of "spina ventosa" of the long bones of the forearm are instances in point.

The treatment discussed is both conservative and surgical. The surgical procedures

are well described and adequately illustrated. In the knee joint resection, removal of the patella and internal fixation by metallic staple or wire is advocated. In the active tuberculous hip joint an extra-articular type of operation, using a tibial graft between the trochanter and iliac crest, is recommended. Another operation using an osteoperiosteal graft from the wall of the ilium that is moved down on the neck of the femur and beneath the up-lifted trochanter, is recommended for old tuberculous disease. For Pott's disease in childhood, conservative treatment up to the age of sixteen is advocated. Beyond this age the majority of cases are considered surgical. The authors illustrate the above types of operations, as well as the Albee, the Hibbs, and osteoperiosteal graft methods.

For a complete text on the subject of bone and joint tuberculosis the authors have produced a remarkable work. It is beautifully printed and illustrated and should enjoy a wide use among roentgenologists as well as those interested in the care of tuberculosis of the bones and joints.

ROENTGENOLOGISCHE BEOBSACHTUNGEN UEBER DIE BEWEGUNGEN DER WIRBELSAULE. By SIGVALD D. BAKKE. From the Städtisches Krankenhaus "Haukeland," Bergen. Supplementary Volume XIII, Acta Radiologica. Kungl. Boktryckeriet. Published by P. A. Norstedt & Söner, Stockholm, 1931.

This little presentation of 75 pages of text and 24 excellent illustrations printed on fine paper sets forth the results of the author's roentgenologic observations on the movements of the spinal column. The results arrived at are somewhat different from those of other writers. For instance, the author finds that, contrary to the opinion of Professor Fr. Müller, the roentgenologic method holds good in examinations of the mechanism of flexion of the spinal column. The flexibility increases and decreases evenly from vertebra to vertebra along the whole of the spine. There are nowhere any inflexible parts interposed between the flexible parts. This is true of forward and backward bending as well as of lateral flexion.

JAMES T. CASE, M.D.

X-ray "Baths" Now Possible for Patients with Tumors.—X-ray "baths," which irradiate the whole body of the patient for long periods, instead of attacking local spots intensely but briefly, are now available at Memorial Hospital, New York City. They are designed for the treatment of patients suffering from deep tumors. Both the means and the technical knowledge in the development of this special ward were supplied by the late Arthur C. Heublein, M.D., who sacrificed his life to it through illness induced by overwork. The ward consists of four beds arranged about an X-ray machine capable of continuous operation at 185,000 volts and three milliamperes. The patients are kept bathed in its continuous discharge.

It is too early as yet, Dr. Failla said in reporting the new set-up for tumor treatment, to permit the clinicians at the hospital to draw definite conclusions as to the efficacy of the new method. However, some striking results have been obtained in a few cases of generalized radiosensitive tumors, which could not have been obtained by the ordinary methods of X-ray therapy.

H. J. Bagg, Ph.D., also of Memorial Hospital, told of animal experiments performed in this same X-ray "bath." Mice with transplantable tumors have been exposed to the radiation for several weeks, with the result that their life has been prolonged very materially. This has been accomplished without apparent ill effects, since the body weight has remained normal.

ABSTRACTS OF CURRENT LITERATURE

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PELVIS

The Ossification of the Iliolumbar and Iliosacral Ligaments. A. Reisner. *Röntgenpraxis*, Nov. 15, 1931, III, 1026-1034.

The iliolumbar and iliosacral ligaments are visible in about 3 per cent of roentgenograms of the pelvis. Their visualization does not indicate pathologic changes. In 0.8 per cent, the shadow is marked and in 0.4 per cent, an ossification could be demonstrated. Thirteen cases are described in detail. Definite points for the etiology of this ossification could not be found. The assumption that it might be an abnormal development of the costal portions of the transverse processes is considered improbable. The author explains it by regenerative hyperplastic processes originating in the periosteum. Infectious arthritic processes or injuries may act favorably for the ossification.

H. W. HEFKE, M.D.

PHYSIOTHERAPY

Physical Therapy in Raynaud's Disease. Charles R. Brooke. *Med. Bull. Veterans' Administration*, December, 1931, VII, 1174-1178.

Raynaud's phenomenon is a vascular change, without organic disease of the blood vessels, seen in the extremities, in which a persistent ischemia leads to a vasomotor disturbance of a varying intensity with impairment of function of the circulation, or to a loss of vitality with ultimate necrosis. The author divides the symptomatology into mild, moderate, and severe types.

The symptoms found in the mild grade of Raynaud's never exceed the usual vascular disturbances seen in chilblains. In the moderate type the symptoms are those of intermittent claudication, tired feeling, cramps in the thigh and calf muscles, and sensations of heat and cold throughout the affected extremity. Headaches, fatigue, lack of energy, and alterations in character also occur as a result of claudication of the nervous centers. In the severe type, pains, swelling, and gangrene of the affected extremities are present.

In the treatment of this condition the author has obtained favorable results with the use of physiotherapy. As the initial treatment, radiant light and heat are used, employing a lamp carrying a 1,000 or 1,500 watt bulb and a good reflecting surface. The lamp is placed over the affected extremity for from 20 to 30 minutes at a distance of from 24 to 30 inches. Instead of this procedure, in some cases the affected extremities should be immersed in a warm whirlpool bath for from 10 to 15 minutes as the initial treatment. Both of these methods should be tried to note which gives the most beneficial results in the particular case. This application should be followed by a 10- to 15-minute treatment of surface high frequency, using a medium size non-

vacuum electrode connected to the Oudin transformer of a high frequency machine. If there is no response, the static brush effleurage should be used for 10 to 15 minutes to relieve congestion by increasing absorption in and around the affected areas.

Diathermy has been found to be the treatment of choice in the local therapy of the moderate cases of Raynaud's disease because of its vasodilator action on the small arteries and capillaries. The current strength should not exceed 1,000 milliamperes in the average case. The technic depends on the existing conditions, the symptoms present, and the extent of involvement, but as a general rule, the plate cuff technic has been found to be the most effective. Both upper and lower extremities can be treated at the same time by using a high-frequency diathermy which is equipped with knobs for each hand grasp and a foot rest covered with metal foil. The diathermy application should be followed by a sedative surface high frequency application.

Systemic treatments should be employed in severe cases as an adjunct to the local treatment. General warming of the body is secured in a light and warm cabinet and should be followed by a needle-spray bath. Then, mild Scotch douche sprays should be administered to the entire body. The application of auto-condensation given in the usual way for 15 to 20 minutes, using a current strength between 500 and 750 milliamperes, has been found of considerable value. Ultra-violet radiations have been found to be beneficial in some cases of Raynaud's disease in which the physical resistance is below par.

J. N. ANÉ, M.D.

RADIATION

Radiotherapy in Feeble-minded Children. Dr. Georg Freiherr v. Wicser. *München. med. Wochenschr.* Nov. 6, 1931, LXXVIII, 1904-1908.

In 1911, Bordier reported encouraging results in the roentgen treatment of poliomyelitis anterior. Others confirmed these results. Babinski and Hermans successfully treated myelitis due to meningitis traumatica. It was only through the paper of Hidenhain and Fried that these results could be explained by the action of the radiation on the inflammatory tissue.

The author has extended the field by radiating brain conditions which were due to inflammation. This includes disturbances in the function of the cerebrum due directly to inflammation or trauma, functional disturbance of the inner-secretory system. Best results were seen in mongoloid children in which 80 per cent showed good improvement. Other conditions were dysgenital imbecility, epilepsy, dementia, and conditions resulting from encephalitis and meningitis. It is of little importance, when the symptoms are of a disease to be treated, as long as the underlying condition is understood. The results vary according to the individual case and the

between one-twentieth and one-third of an erythema dose.

ERNST A. MAY, M.D.

Roentgen Treatment of Agranulocytosis. Albert E. Taussig and Paul C. Schnobelen. *Jour. Am. Med. Assn.*, Dec. 12, 1931, XCVII, 1757-1761.

Werner Schultz defines this disease as "an acute febrile disease with angina, prostration, and jaundice, a normal red blood picture, extreme leukopenia with almost or quite complete absence of granulocytes, a normal number of blood platelets, with absence of any tendency to hemorrhage, and an invariably fatal ending." Cases were reported lacking one or more of these cardinal symptoms. Agranulocytosis is characterized by fever, usually but not always by ulcerative processes, leukopenia with great diminution of the granulocytes, and nearly normal blood platelets. At autopsy a very characteristic change is found in the bone marrow, consisting in a great paucity of the myelogenous white cells, which are also absent, or nearly so, in any inflammatory foci that may occur.

A myelopathy occurring in the course of anti-syphilitic treatment, most frequently after the use of one of the arsphenamines, was known for some years before Schultz's agranulocytosis was recognized. The metallic poison depresses all the functions of the bone marrow, adding an anemia, often extreme, and a sharp reduction in the blood platelets with a resulting tendency to hemorrhage. This offers a much more favorable prognosis than true agranulocytosis. Cases of agranulocytosis have been repeatedly observed to pass over into acute lymphatic leukemia.

Friedemann reported a large proportion of all cases treated by means of the X-ray. His mortality, excluding moribund patients, was 48 per cent. Other observers had a mortality of 57 per cent, and the authors, 50 per cent.

Transfusions and roentgenotherapy are useful in the treatment of agranulocytosis, irradiation of the long bones giving the better results.

CHARLES G. SUTHERLAND, M.D.

RADIATION INJURIES

The Cause and Prevention of Radiodermatitis. H. H. Hazen. *Jour. Am. Med. Assn.*, Dec. 19, 1931, XCVII, 1881-1885.

This is a study of 111 cases, following the application of either X-rays or radium. Three resulted from the taking of roentgenograms; thirteen from high voltage therapy; seven occurred in roentgenologists; thirteen were from treatments received in beauty shops; the remainder, or seventy-five, from superficial therapy. Ninety-seven showed signs of injury before the expiration of twelve months, and an additional eight before two years had elapsed.

Four showed nothing for three years, and in two the first signs of trouble appeared after forty-eight months. There are a few cases on record in which the appearance of telangiectasis has been delayed even beyond four years.

Tables show the location of the radiodermatitis and character of injuries, conditions for which treatment was given, and types of cases resulting in serious keratoses. Many patients suffering from comparatively benign conditions were among those most seriously damaged. Another table reviews the causes of the lesion.

C. G. SUTHERLAND, M.D.

RADIUM

Non-destructive Testing by Gamma Rays from Radium. Robert F. Mehl. *Jour. Am. Soc. Naval Engineers*, August, 1931, XLIII, 371-395. (Reprinted by permission from "Metals and Alloys.")

The author describes the apparatus used by the Naval Research Laboratory and discusses experiments carried out on steel castings. A large number of photographs and radiographs are presented, showing the results obtained. It is inevitable that this new method of radiographic inspection should be compared with the X-ray method. This new method offers advantages in greater simplicity of operation, almost complete portability, far greater penetration, and more satisfactory performance on irregular sections. It suffers from the rather longer exposure times and from the lack of general availability of radium. The cost of an inspection method is naturally of very great interest to industry and before it can be claimed that this new method will have a wide application, it will be necessary to show that its costs are not prohibitive. Such surveys as have been outlined in this paper, however, indicate that a sensible prosecution of the method industrially should result in costs which are well within the admitted range of inspection costs. It is of interest to note that the Navy has considered the matter carefully and has decided to provide the Navy Yards on the East Coast with radium for this purpose. This radium will be held at the Naval Research Laboratory. The total amount will be one-half gram divided into three portions, so that separate portions can be sent to the various Yards as required.

Radiotherapy in Basedow's Disease. Halberstädter. *München. med. Wchnschr.*, Dec. 25, 1931, LXXVIII, 2189, 2190.

All of the six patients who died in coma after radium application in Basedow's disease had such severe complications that it is impossible to state exactly whether or not the radium applications had made the condition worse. It may be said that apparently three cases were aggravated by the radium.

The doses were very small and similar to the ones used by others. At any rate, the condition of all six patients was such that any kind of treatment or other outside influence might have resulted in coma. To avoid all doubt, the author suggests that we remember that extreme cases may react by increased symptoms. He advises either giving the patient an almost fictitious treatment, or an initial treatment of the spleen or thymus in order to learn what the psychic or physiologic reaction of the patient may be in each case.

ERNST A. MAY, M.D.

Roentgen Carcinoma Cicatrized by Radium. A. H. Roffo. *La Prensa Méd. Argentina*, Nov. 10, 1931, XVIII, 742-751.

The author presents the case of a well-known radiologist, Lucio O. Aravena. He gives a short résumé of the literature on the subject and concludes that he does not understand why physicians are afraid to use radium in such cases. He also wonders why they will make use of surgery when the results are so unsatisfactory. He states that when epithelial cells have reached a neoplastic state, they acquire a new biologic state which gives them a special characteristic—that of malignancy—regardless of the etiologic factor. The belief that roentgen cancer gives a different reaction to irradiations has cost many lives and much loss of time.

In the case that he presents, the author instituted radium therapy, resulting in a few days in the disappearance of agonizing pain. In two months the multiple lesions, all ulcerative and two very deep, were replaced by scar tissue. He concludes by introducing a letter written by the radiologist-patient, giving an outline of the many years he had suffered, the evolution of the lesions, and their final cure with the radium.

N. G. GONZALEZ, M.D.

RICKETS (THERAPY)

Irradiated Milk: The Energy Requirements for Antirachitic Activation. G. C. Supplee, M. J. Dorcas, and Alfred F. Hess. *Jour. Biol. Chem.*, 1932, XCIV, 749-763.

Physical data indicating the character and the amount of radiant energy required for the antirachitic activation of milk are presented and coordinated with the biologic and clinical tests. The irradiation of the milk was carried out in 1,000-pound lots under commercial conditions which permitted a precise study of various factors. With a suitable quality and quantity of radiant energy applied under uniform conditions, the antirachitic and calcifying properties of milk can be regularly increased within a few seconds, as determined by biologic laboratory assays and clinical tests on infants. This high degree of activation is obtained without

the development of adverse secondary reactions which may occur after long periods of exposure.

The energy of the radiations from a suitable C lamp of the flaming arc type and a SiO_2 -Hg vapor lamp confers definite antirachitic and calcifying potency on milk treated according to the technic described. However, the spectral energy characteristics of the radiations from the C arcs are readily subject to control, both as to the quality and quantity of the energy. Milk irradiated under controlled conditions and subsequently dried by the Just process was found to protect even colored infants from rickets during the winter months. Such milk also manifested definite curative value in a number of cases.

CHEMICAL ABSTRACTS.

An Investigation of the Comparative Ash Contents of the Metaphyses and Shafts of Bones. Alfred H. Hess, Frieda S. Berliner, and Mildred Weinstock. *Jour. Biol. Chem.*, 1931, XCIV, 9-19.

Determinations of ash show that osteoporosis of the shaft accompanies rickets in rats and runs parallel with the loss of ash in the rachitic metaphyses. In the course of healing, not only is the absolute amount of ash deposited in the metaphyses greater than that deposited in the shaft, but calcification of the metaphyses proceeds at a more rapid rate than in the shaft. The bone ash of normal older rats is higher than that of younger rats, whereas the inorganic P of the serum is lower in the older rats. The deposition of as little as approximately 1 mg. of ash when laid down in the rachitic epiphysis can be noted by X-ray film.

CHEMICAL ABSTRACTS.

ROENTGEN-RAY (INDUSTRIAL APPLICATION)

New Applications for the X-ray are Continuously being Discovered. Don S. Brown. *Electric Journal*, February, 1931, XXVIII, 88-90. (Reprinted by permission from "Metals and Alloys.")

This is a review, indicating the applications of the X-ray to the medical, therapeutic and industrial fields, arts, and sciences. X-rays have been used to detect flaws and blow holes in castings; to inspect welds and insulated electric conductors; to check the workmanship of complex mechanical assemblies, such as shells; to detect impurities in sugar and flour; to determine the amount of ash in coal, and the proportion of fat to lean in canned beef, etc.

The Use of X-rays in the Study of Pearls. B. W. Anderson. *British Jour. Radiol.*, 1932, V, 57-64.

Oriental pearls and cultured pearls show different Laue diffraction patterns in the X-ray beam. Photographs are given of diffraction patterns for both types of pearls and of certain crystals.

CHEMICAL ABSTRACTS.

TUBERCULOSIS (DIAGNOSIS)

Fourth National Congress in the War against Tuberculosis (Bologna, October, 1931). The Onset of Pulmonary Tuberculosis in the Adult. A. Gasbarrini. *Il Giornale di Tisiologia*, Dec. 31, 1931, 237, 238.

The importance of the fight against tuberculosis in all countries impels physicians to recognize the disease at the earliest possible moment. In place of the old doctrine of an insidious, gradual, and slow invasion of pulmonary tuberculosis in the adult, there has been substituted of recent years the concept of an acute start and development.

The recent roentgenologic acceptance of the so-called apical infiltrate by Assmann and the resulting studies of Redcker have strengthened this view and have aroused heated discussion regarding the genesis of the infiltrate. In addition to the apical theory, we have the conception, recently revived by Italian investigators, according to which, in processes of tuberculous reinfection, great importance is to be attributed to the lymphatic glandular system. The disease, starting thus in the glands of the hilus, is believed successively to invade the pulmonary parenchyma by a retrograde course in all directions, at one time in the neighborhood of the hilus, at another along the interlobular spaces, again, and by preference, in the infraclavicular region, and finally in the apex. Hence, when the pulmonary apex is seen to be involved, the first manifestation (clinical and radiologic) does not coincide with the initial localization of the tuberculous process, but marks a late stage in the course of the disease evidenced by the infection which started in the glands of the hilus. The infiltrate of Assmann represents, therefore, the second, not the first stage, as claimed by Redcker.

Roentgenographic examination (particularly fluoroscopic), even though most accurate and carried out with perfect technic, does not always succeed in revealing the most delicate structural alterations, especially of the apex. Accordingly, roentgenographic findings must be interpreted with the greatest caution, as certain images cannot always be referred to parenchymal foci. Roentgenologic investigation is most uncertain when it is a question of interpreting the density of the shadows in the region of the hilus and the so-called striæ of Sturz, since Busi demonstrated that there does not exist in the adult a hilus of normal type and that the term "peribronchitis," taken in the sense of "lymphangitis," has been subject to abuse. Besides, roentgenologic investigation gives us no, or little, information, regarding the activity of the lesion. Roentgenologic examination, therefore, should always supplement objective examination but should never be a substitute for it.

W. W. WHITELOCK, Ph.D.

The Roentgenologic Diagnosis of Lymphogranulomatosis and Tuberculosis. M. Werner. *Röntgenpraxis*, Dec. 15, 1932, III, 1114-1116.

Tuberculosis of the lungs and hilus glands may occasionally be mistaken for Hodgkin's disease. Roentgenograms of the case described showed a large glandular mass in the right hilus, with infiltration extending from it into the lung, this being considered typical of Hodgkin's disease. A biopsy of enlarged cervical glands was diagnosed as probable lymphogranuloma. Sputum examination did not show tubercle bacilli. After roentgenotherapy the tumor decreased in size, which was also considered a sign of Hodgkin's disease. An autopsy, however, showed no evidence of lymphogranuloma, but only tuberculosis of the lungs and glands.

H. W. HEFKE, M.D.

Feminine Sterility and Tuberculosis. Vital Aza. *Rev. Méd. Cubana*, December, 1931, XLII, 1490-1503.

About 18 per cent of sexual unions remain sterile due to feminine incapability. The cause of 60 per cent of sterility in women is the gonococcus. Of the remaining 40 per cent, tuberculosis of the adnexa is the prime offender.

In the uterus there are two types of tuberculous infection: (1) The ulcerating, and (2) the vegetating or papillary type. The author believes that many of the brilliant surgical or roentgenologic results in cancer of the neck of the uterus are due to the fact that such lesions are tuberculous and not cancerous. Many cases of sterility are probably due to a metritis, having its origin in a tuberculous infection, though such a condition does not necessarily cause sterility. The most common site for genital tuberculosis is the fimbriated ends of the fallopian tubes and the result is an occlusion of the tubes with consequent sterility. Many times, the infection progresses and invades the ovaries from the tubes, sometimes even involving the peritoneum. Many authors claim that from 85 to 90 per cent of tuberculous peritonitis occurs in women, the reason being that the male genital organs are extra-peritoneal.

The author goes into great detail concerning the symptoms and clinical findings of the disease, and in regard to the treatment, he states that surgery cannot restore function, but can usually cure by means of extirpation of the involved organs. He has obtained excellent results with radiotherapy.

N. G. GONZALEZ, M.D.

Roentgenologic Aspects of Childhood Tuberculosis. Benjamin Goldberg. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1931, XXVI, 397-407.

The "childhood type of tuberculosis" is the term given to the first infection by the tubercle of a small

area of lung structure with secondary hilus lymph node involvement. This may occur in infancy, at any age of childhood, or even in adult life. Too often the clinician is tempted to make the diagnosis on indefinite physical signs plus a positive tuberculin reaction; the roentgenologist likewise may give an opinion of tuberculosis on indefinite hilus changes.

It is the author's opinion that only a careful correlation of history, physical signs, laboratory tests, and X-ray findings make for an accurate diagnosis. Physical findings are quite variable and usually inconclusive. A negative tuberculin test only when properly done and upon repetition found again negative may be considered positive evidence against tuberculosis, although the author admits that cachexia, grave tuberculosis, measles, pertussis, and scarlet fever may reduce or abolish allergy; hence, in such cases, only a negative skin reaction can be expected. Likewise a positive test merely indicates a hypersensitiveness and does not prove the presence of a chest lesion.

The roentgenologic evidence may be of greatest help or greatest hindrance in a correct diagnosis, dependent upon the skill and care of the examiner. The primary tubercle (Ghon tubercle) is usually subpleural and more often in the right lower than left lower or upper lung field. This original focus may not be demonstrable unless of sufficient size and calcified or associated with an area of caseation. The associated hilus involvement likewise varies greatly and may produce changes not sufficient to be detected, or large dense caseating gland masses, easily seen, may be present.

Miliary tuberculosis in infancy or childhood may give a rather characteristic mottling, or if the tubercles are small and not associated with appreciable coalescence, the roentgen findings may be negative. Erituberculosis, a specific infiltration of a large area of lung tissue, may be considered a form of allergy reaction; this condition will, of course, produce roentgen changes, but these may be so dense as to obscure the primary focus and merely indicate the presence of a pneumonic consolidation or area of atelectasis. The apical form of tuberculosis occurs occasionally in older children, and clinically and roentgenologically it resembles the same type in the adult. The author believes that the history, physical findings, and laboratory evidence should be available to the roentgenologist at the time of the roentgenologic interpretation.

J. E. HABBE, M.D.

Roentgen Diagnosis of Tracheobronchial and Pulmonary Tuberculosis: Its Value. Merl L. Pindell, Calif. and Western Med., February, 1932, XXXVI, 81-87.

In this paper the author discusses the methods

used in the Los Angeles County Health Department in the early discovery of pulmonary tuberculosis. He also discusses the significance of roentgen diagnosis. The physical findings may not demonstrate pulmonary tuberculosis, even though it is present. Definite parenchymal changes are seen in nearly all X-ray films of proven pulmonary tuberculosis. The absence of such changes demands other proof of the existence of the disease. The insurance companies could save thousands of dollars and be of greater benefit to mankind by including X-ray examination of the chest in their medical examinations.

In an examination of 197 high school children, 30 per cent of whom were known to have had contact with tuberculous patients, only two cases of pulmonary tuberculosis were found. One of these had no clinical symptoms or physical signs, the diagnosis being made with the X-ray alone. Clinical symptoms and underweight are more or less common to non-tuberculous children.

The writer believes that the X-ray is the only reliable method of diagnosing tracheobronchial tuberculosis. He considers all enlarged intrathoracic lymph nodes in a child as tuberculosis.

"The only time that tuberculosis has a marked tendency to heal is in the earliest stages, when it is localized; therefore, this is the time at which it should be diagnosed, and the X-ray ranks supreme in showing these early lesions. There is no secret in the accuracy with which the X-ray depicts dense tuberculous lesions, but there is probably an art in being able to distinguish slight, fine, tuberculous mottling in the lung from the normal lung markings. Roughly speaking, any confluent densities or discrete, fine mottling, or coarse nodular infiltration in the upper half of the lungs of an adult should be considered tuberculous until proven otherwise. These markings must be entirely distinct from the linear markings of the lungs. Most of the lesions located in the lower half of the lungs should be considered non-tuberculous until proven otherwise. But many times characteristic nodular densities are observed in the bases and, of course, represent tuberculosis."

The author believes that the disease is not arrested so long as the X-ray shows densities not completely fibrosed or calcified. When the X-ray shows characteristic infiltration not completely fibrosed or encapsulated, the patient is still in a dangerous condition and should be treated.

It requires a great deal of experience to properly interpret X-ray films. The author believes that many physicians try to read too much into the film. All children that are contacts or have a possible tuberculin reaction should be roentgenographed. The time has arrived for the public to demand X-ray examinations of the chest, when applying for periodic examinations.

FRANCIS B. SHELDON, M.D.

TUBERCULOSIS (THERAPY)

Phrenicectomy in the Treatment of Pulmonary Tuberculosis. G. Gullotta. *Archivio Italiano di Chirurgia*, November, 1931, XXX, 361-392.

After tracing the history of resection of the phrenic nerve in the surgical treatment of pulmonary tuberculosis and describing the method of procedure, indications, and effects, the author presents a series of tables founded on clinical and radiological observations showing the results of the operation in 42 personal cases. Indications for the intervention cover a fairly wide field. On the basis of the encouraging results obtained, the author recommends this mild operation, which is made without special preparation, as an effective weapon under certain conditions against pulmonary tuberculosis.

W. W. WHITELOCK, Ph.D.

Indications for Radical Surgery in Tuberculosis of the Kidney. Alfred I. Folsom. *Urol. and Cutan. Rev.*, February, 1932, XXXVI, 75-79.

While tuberculosis of the kidney has for a long time been considered a purely surgical condition, an effort has been made to revive the medical type of treatment. In 1924, Medlar established the fact, from experimental work on guinea pigs and rabbits, that whenever an actual bacilluria existed, there was in every case a definite lesion of the renal substance. This lesion was sometimes microscopic in size and could in some instances be found only by careful serial sections, but in each case the lesion was definitely demonstrated. This work of Medlar emphasized the difficulties of an early clinical diagnosis, and the fact that before a tuberculous lesion of the kidney can be diagnosed it must have reached a fairly well-developed state. At this advanced stage the lesion, as a rule, will produce a definite diminution of the kidney function or some change in the kidney that will be recognized by a modern roentgen examination of the urinary tract.

The roentgenologic findings in this condition are as follows: Irregular calcified deposits in the cortical or medullary lesion, which are fairly distinctive and may be proved by a pyelogram to be outside the pelvis; in the pyelogram a ragged or moth-eaten appearance of the margin of one or more of the calices, with or without dilatation; characteristic multiple narrowings of the ureter, as seen in the ureterogram; complete or partial obliteration of the whole or a part of the kidney pelvis. A kidney showing these changes becomes at once a definite clinical entity.

The symptomatology of tuberculosis of the kidney is often confusing, for there are no characteristic symptoms of this condition, the outstanding one usually drawing the attention of the urologist from the kidney to the bladder. The author agrees with Cabot, Casper, Rovsing, and others that a diagnosis of clinical tuberculosis of the kidney cannot be made

on the finding of a few tubercle bacilli in the urine. For this reason, they believe that a kidney should never be removed until more substantial evidence is present to convict it.

While the majority of clinical surgeons are of the opinion that, in the largest number of clinical cases of tuberculosis of the kidney, the condition is unilateral, Medlar, Thomas, and Kinsella believe that the disease is usually bilateral. However, the author expresses the view that the renal tuberculosis produced experimentally by Medlar does not correspond to a chronic renal tuberculosis, but to an acute miliary tuberculosis. Similarly, the autopsy findings of patients who have died of tuberculosis are often a manifestation of a terminal miliary tuberculosis. Some authors report the existence of bilateral renal tuberculosis in from 88 to 100 per cent of cases, while others consider that 12 per cent represents the occurrence of bilateral lesions in this condition. It is the author's opinion that two entirely different pathologic entities are considered by these investigators. He points out the fact that in reviewing Medlar's 30 autopsy cases, in spite of a generalized tuberculous infection, he found not a single case of caseo-cavernous tuberculosis. Likewise, in spite of numerous small lesions occurring in the 60 kidneys, in individuals debilitated by a generalized tuberculosis coming to autopsy, there was not one case in which any of the clinical evidence of tuberculosis of the kidney was present.

The author concludes that it is his opinion that once a clinical diagnosis of renal tuberculosis is made, the one and only rational procedure is the removal of that kidney, as soon as possible. However, the remaining kidney should show a normal capacity to excrete indigo carmine or phenolsulphonphthalein, and the urine from this kidney should be cytologically clear.

J. N. ANÉ, M.D.

TUMORS (DIAGNOSIS)

The Diagnosis of Lung Tumors. Richard Epstein. *Röntgenpraxis*, Dec. 1, 1931, III, 1057-1062.

The number of symptoms, which are supposed to be characteristic for bronchial or lung tumors, is large. Some of them can be depended on only to a small degree. The most important diagnostic means are: roentgenograms, bronchoscopy (biopsy), bronchography with iodized oils, and pneumothorax. A roentgenologic examination should be done in all questionable cases, it being of greatest importance, also, in all cases with a primary tumor in another location, in order to determine the presence or absence of lung metastases. Rather often surgical removal is attempted when a roentgen examination would have shown metastases in the lungs.

H. W. HEFKE, M.D.

area of lung structure with secondary hilus lymph node involvement. This may occur in infancy, at any age of childhood, or even in adult life. Too often the clinician is tempted to make the diagnosis on indefinite physical signs plus a positive tuberculin reaction; the roentgenologist likewise may give an opinion of tuberculosis on indefinite hilus changes.

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FRANCIS B. SHELDON, M.D.

The author then discusses the clinical value of the protracted fractional dose method by briefly analyzing the reports available so far in the literature. He then briefly quotes 10 cases of his own which led him to the preliminary conclusion that the application of this treatment method undoubtedly may show results where other methods or means of treatment will fail. From the characteristic reaction produced in mucous membranes, which is so different from the reaction following the single application of a high dose, the principal difference between the protracted fractional dose method and other treatment methods can clearly be seen. It is also most interesting to note that in spite of the high total doses administered, only in rare instances do patients develop X-ray sickness or lose weight. It is necessary, however, to carefully observe the cardiovascular system, since definite disturbances appear following the application of large fields. They manifest themselves in lowering of the blood pressure, tachycardia, and arrhythmia. In one of the author's cases death occurred under the typical symptoms of lung embolus. Although this was not proved by autopsy, the author is inclined to see a definite relation between irradiation and death. It is also necessary, of course, to protect kidney, liver, spleen, intestines, and bones as much as possible.

One very important consideration of the protracted fractional dose method is the economical side. Since it takes considerable time to treat one patient, only a very small number of cases can be treated per day. The cost of the procedure is naturally high. At the present time it can be carried out only in institutions in which several machines are available. A most complete bibliography concludes the paper.

ERNST A. POHLE, M.D., Ph.D.

Results of Protracted Fractional Roentgentherapy in Malignant Tumors. A. Zuppinger. *Strahlentherapie*, April 13, 1932, XLIII, 701-718.

The author reports 20 cases of malignant tumors, treated by the Coutard method, which were free of symptoms for at least one year at the time of writing the report. Exposure was usually over two or three fields. The doses in air amounted to from 150 to 200 r per sitting, which were applied in from 48 minutes to two hours. For economical reasons the latter period was finally reduced to one hour. Some patients received total doses of 7,000 r.

In 19 out of 20 cases the diagnosis was confirmed histologically. There were 18 carcinomas and 1 sarcoma. In only 4 cases would surgery have been possible; however, a most radical and mutilating operation would have been necessary. In 2 cases radium had to be used in addition to roentgen rays, and in 2 other cases surgery, in addition to irradiation.

From the analysis of the cases the author concludes that the chances of cure depend chiefly on the type of metastases and secondly on the extension of the primary tumor. The general condition of the patient and the histologic structure of the tumor play extremely important rôles. Very definite indications must be observed, in order to treat only suitable cases with the protracted fractional dose method.

ERNST A. POHLE, M.D., Ph.D.

ULCERS (ETIOLOGY)

Neurogenic Factor in Chronic Peptic Ulcer. Witten B. Russ. *Jour. Am. Med. Assn.*, Nov. 28, 1931, XCVII, 1618-1620.

The etiology of peptic ulcer and its pathogenesis are yet to be determined. Most observers admit there is some predisposing cause yet unknown. The ulcer-bearing individual belongs to a distinct type and from birth is predisposed to the development of chronic peptic ulcer. This type is the high strung, emotional, so-called vagotonic individual, with a sensitive nervous system and certain physical peculiarities which clearly distinguish him from the opposite or sympathetotonic type, showing marked visceroptosis and being subject to melancholia, lassitude, headaches, and atonic constipation. Many observers have emphasized the importance of the nervous element in the production of ulcer. It is a well-known fact that patients resistant to treatment by rest, diet, and alkalis often recover completely and suddenly from their symptoms when they are made happy by some occurrence, change of residence or occupation.

Both experience and common sense point to the conclusion that the mystery connected with the origin and behavior of chronic peptic ulcer is in some way related to the patient's nervous organization and his physical make-up.

CHARLES G. SUTHERLAND, M.D.

TUMORS (THERAPY)

Roentgenography in Brain Tumors: Its Value and Limitations without Ventriculography or Encephalography. J. Gershon-Cohen. *Am. Jour. Roentgenol. and Rad. Ther.*, September, 1931, XXIV, 414-427.

This study is based on 221 cases of brain tumors, with microscopic pathologic diagnosis made either following operation or at autopsy. Ninety-seven cases were in the cerebrum, 65 in or around the pituitary fossa, and 59 in the cerebellum.

In the 65 cases of pituitary body or suprasellar tumors originating from the pituitary body 58, or 89 per cent, gave localizing roentgen signs. The important roentgen signs and their frequency of occurrence in this series were: Alteration in size and shape of sella, 90.8 per cent; atrophy of the dorsum sellæ and posterior clinoid processes, 80.5 per cent; atrophy of the anterior clinoids, 7.7 per cent, and erosion of one side of the sella, 6.2 per cent.

In the 97 cases of cerebral tumors 55, or 56 per cent, were diagnosed from the plain roentgen examination, 26 cases showing localizing signs. Localizing signs and their frequency of occurrence were: Calcification within the tumor, 11.3 per cent; local bone atrophy, 12 per cent; local bone hyperostoses, 6 per cent. Diagnostic signs due to increased intracranial pressure were: Atrophy of the dorsum sellæ, 30 per cent; convolutional atrophy, 11 per cent, and prominence of the diploic channels, 16 per cent. It was observed that in this group the glioma, occurring most frequently of all cerebral tumors, showed no roentgen evidence of its presence in 59 per cent of the cases and underwent calcification with resultant localization in only four cases.

Of the 59 cases of cerebellar tumors only 50 per cent gave positive findings, with only two showing definite localizing signs in the nature of local bone atrophy. Whereas the cerebral tumors showed convolutional atrophy in only 11 per cent in cerebellar tumors (because of earlier obstruction to the fourth ventricle or aqueduct of Sylvius), convolutional atrophy was demonstrable in 30 per cent of the cases. Atrophy of the dorsum sellæ was present in 22 per cent, and diastasis of the sutures, in 10 per cent.

The routine radiographic study consisted of stereoscopic right and left lateral, single antero-posterior views, and a lateral 36-inch teleroentgenogram of the pituitary fossa. In recent years in addition to the above views, a view of the posterior and middle fossæ for study of the superior ridge of the petrous bones has become part of the routine, but the results from this additional projection are not included in this study.

J. E. HANBE, M.D.

The Theoretical, Experimental, Clinical, and Economic Foundations of Protracted Fractional Roentgenotherapy of Malignant Tumors. H. G. Zwerg. *Strahlentherapie*, Feb. 10, 1932, XLIII, 201-248.

In the introduction the author discusses the theory of the protracted fractional dose method as it has been developed from our knowledge, concerning the biologic effect of roentgen rays on normal and tumor cells. He then presents a detailed report of his own experiments, undertaken in order to determine the rôle played by subdividing the dose and also by protracting it. The skin, white blood count, lung tissue, heart muscle, and kidney reactions were studied in this connection, rabbits being used in all tests.

The technic was as follows: 180 K.V., 4 ma., for protracted treatment, 3.3 mm. Cu + 1 Al; for simple fractional method, 0.5 mm. Cu + 1 Al, half value layers in Cu 2.8 mm. and 0.8 mm., respectively. The daily dose amounted to 180 r, which was reached at 40 cm. F.S.D. in 7½ and 30 min., respectively. The total dose varied between 5,600 and 9,200 r. The animals were killed from one-half to 10 months after the treatment.

From a study of the skin reactions on the back of rabbits it appeared that neither macroscopically nor microscopically was there any difference between animals which were treated by the protracted fractional method and by the fractional method alone. There were no injuries following the application of doses up to 5,600 r, no changes in the blood vessels, and no proliferation in the connective tissues. After such a dose was given in one sitting, necrosis occurred. Degeneration in cell nucleus and in the cell plasma appeared, if there was less subdivision of the total dose than indicated above. If the total dose was increased to 9,600 r, slight injuries were observed and here again the subdividing of the dose was more important than the protraction of the treatment. The study of the leukocyte changes led to a different conclusion. In this case there was a definite variance between the animals treated by fractional doses alone and those treated by protracted fractional doses. The injurious effect was definitely less if the dose was both subdivided and protracted. The same deductions could be drawn from the histologic studies of irradiated lungs. The protraction introduces apparently a great safety factor. The heart muscle proved to be rather resistant to X-rays. A total dose of 7,000 r did not produce definite damage. There was no difference between simple subdivision of the dose and the protracted fractional dose method. A very marked difference between the reactions produced by the two treatment methods was seen in irradiated kidneys. Simple subdividing of the dose produced almost as severe reactions as 400 per cent E.D. applied in one sitting. The protraction is, therefore, of great value as far as irradiation of the kidney is concerned.

The author then discusses the clinical value of the protracted fractional dose method by briefly analyzing the reports available so far in the literature. He then briefly quotes 10 cases of his own which led him to the preliminary conclusion that the application of this treatment method undoubtedly may show results where other methods or means of treatment will fail. From the characteristic reaction produced in mucous membranes, which is so different from the reaction following the single application of a high dose, the principal difference between the protracted fractional dose method and other treatment methods can clearly be seen. It is also most interesting to note that in spite of the high total doses administered, only in rare instances do patients develop X-ray sickness or lose weight. It is necessary, however, to carefully observe the cardiovascular system, since definite disturbances appear following the application of large fields. They manifest themselves in lowering of the blood pressure, tachycardia, and arrhythmia. In one of the author's cases death occurred under the typical symptoms of lung embolus. Although this was not proved by autopsy, the author is inclined to see a definite relation between irradiation and death. It is also necessary, of course, to protect kidney, liver, spleen, intestines, and bones as much as possible.

One very important consideration of the protracted fractional dose method is the economical side. Since it takes considerable time to treat one patient, only a very small number of cases can be treated per day. The cost of the procedure is naturally high. At the present time it can be carried out only in institutions in which several machines are available. A most complete bibliography concludes the paper.

ERNST A. POHLE, M.D., Ph.D.

Results of Protracted Fractional Roentgentherapy in Malignant Tumors. A. Zuppinger. *Strahlentherapie*, April 13, 1932, XLIII, 701-718.

The author reports 20 cases of malignant tumors, treated by the Coutard method, which were free of symptoms for at least one year at the time of writing the report. Exposure was usually over two or three fields. The doses in air amounted to from 150 to 200 r per sitting, which were applied in from 48 minutes to two hours. For economical reasons the latter period was finally reduced to one hour. Some patients received total doses of 7,000 r.

In 19 out of 20 cases the diagnosis was confirmed histologically. There were 18 carcinomas and 1 sarcoma. In only 4 cases would surgery have been possible; however, a most radical and mutilating operation would have been necessary. In 2 cases radium had to be used in addition to roentgen rays, and in 2 other cases surgery, in addition to irradiation.

From the analysis of the cases the author concludes that the chances of cure depend chiefly on the type of metastases and secondly on the extension of the primary tumor. The general condition of the patient and the histologic structure of the tumor play extremely important rôles. Very definite indications must be observed, in order to treat only suitable cases with the protracted fractional dose method.

ERNST A. POHLE, M.D., Ph.D.

ULCERS (ETIOLOGY)

Neurogenic Factor in Chronic Peptic Ulcer. Witten B. Russ. *Jour. Am. Med. Assn.*, Nov. 28, 1931, XCVII, 1618-1620.

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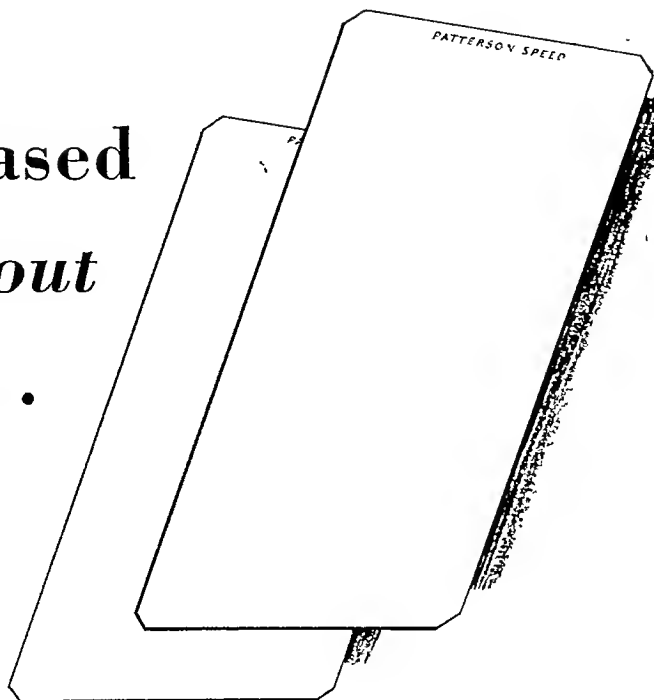
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CHARLES G. SUTHERLAND, M.D.

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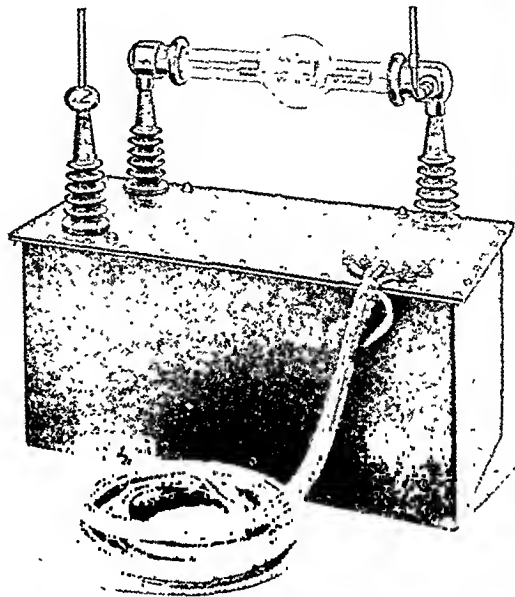
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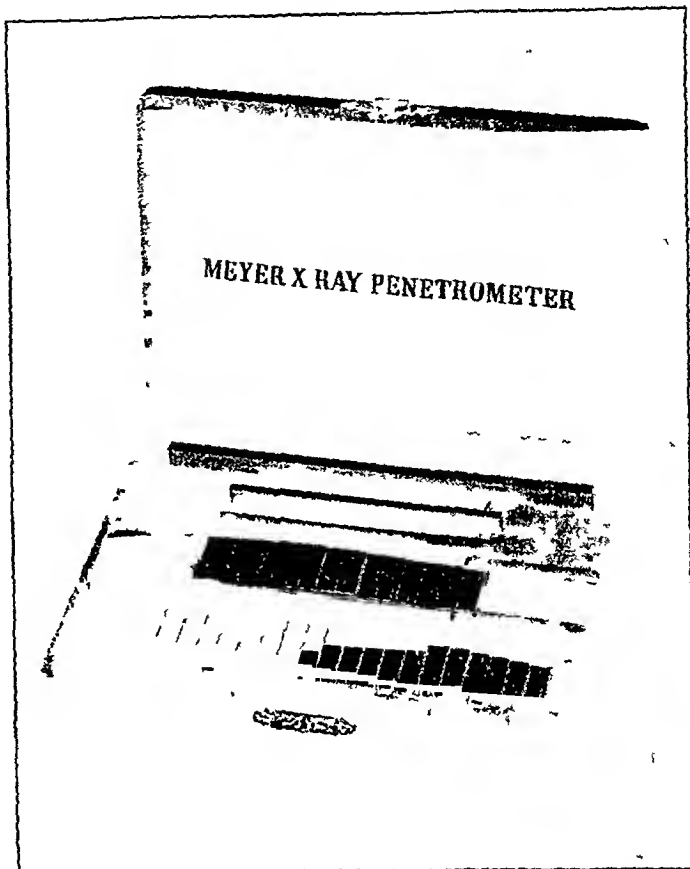
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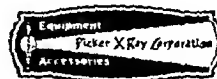


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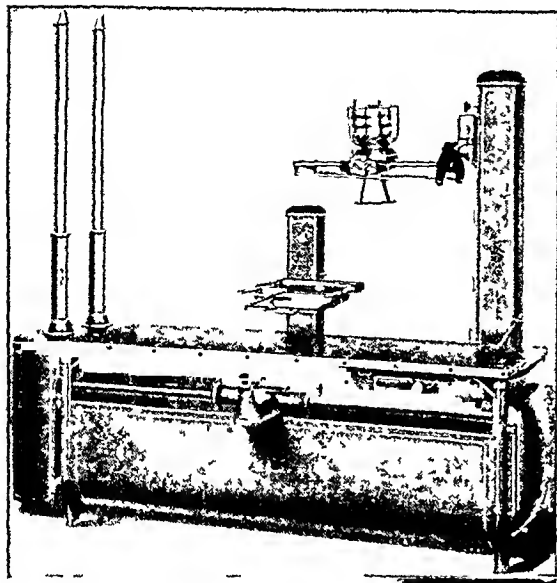
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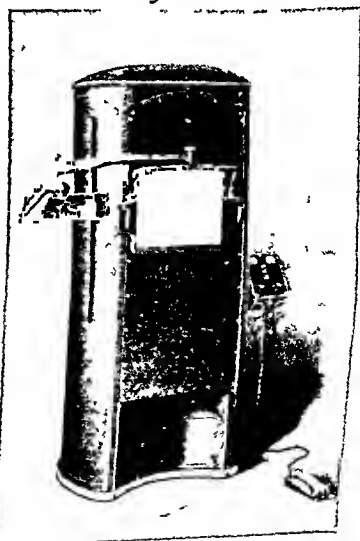
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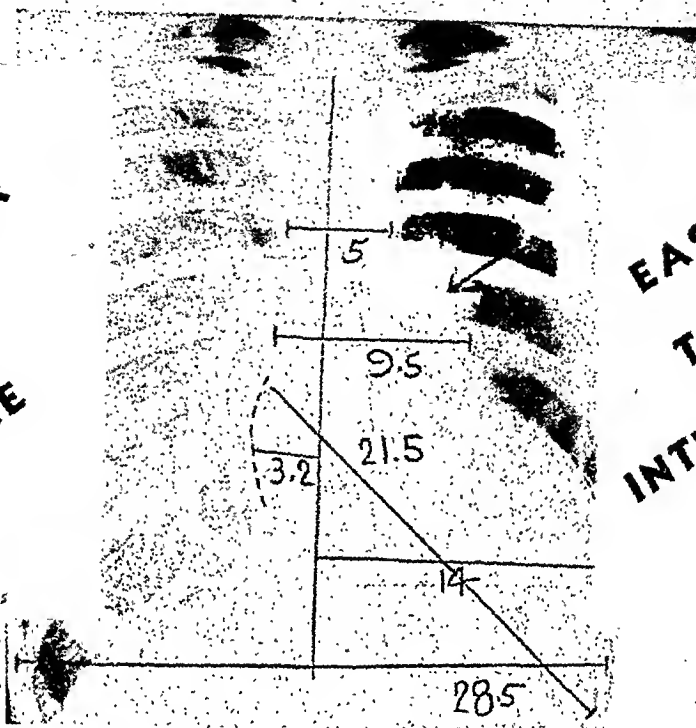
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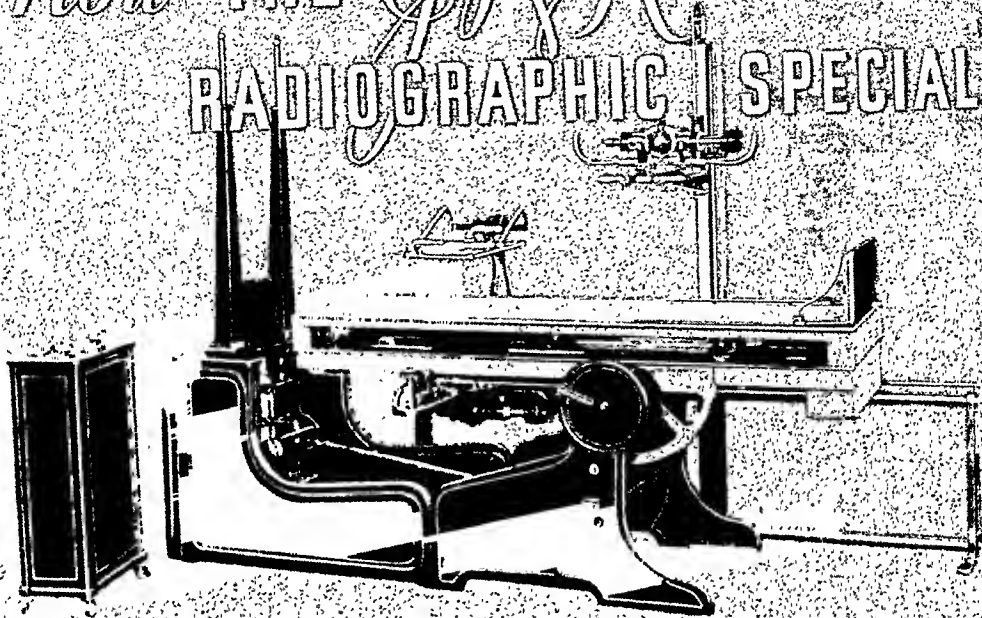
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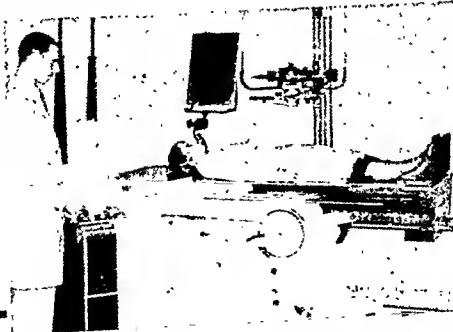


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RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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The next Annual Meeting of the Society, the Eighteenth, will be held in Atlantic City, New Jersey, Nov. 28-Dec. 2, 1932, at the Haddon Hall Hotel.

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No. 4

THE ORGANIZATION OF A TUMOR CLINIC IN A GENERAL HOSPITAL¹

By MAX CUTLER, M.D., CHICAGO

Director of Tumor Clinic, Michael Reese Hospital; Consultant in Tumors, Hines Veterans Hospital

THE TECHNIC OF ORGANIZATION

THE problems encountered in the organization of a tumor clinic in a general hospital differ fundamentally from those met with in the organization of special cancer hospitals, although the ultimate goal is similar. Certain principles are fundamental to the successful operation of a tumor clinic.

1. All patients in whom a diagnosis of neoplasm is made or suspected must receive the benefit of consultation before therapy is instituted.

2. The consultation must include opinions upon the clinical, pathologic, and radiotherapeutic aspects of the disease. The number of individuals participating in the consultation necessarily varies under different circumstances.

3. The most efficient surgical procedures, as well as the most modern and up-to-date radiotherapeutic facilities and technic, must be available to the cancer patient.

4. There must be a rigid and critical follow-up of all patients treated for benign and malignant tumors; careful records must be made of the end-results.

The technic by which these principles are

to be followed can, perhaps, be most easily explained by a statement of the actual operation of the clinic in the Michael Reese Hospital. New patients are referred by the various departments of the hospital to the Out-patient Department of the Tumor Clinic for an opinion. After examination, patients are either referred to the department in which they originated or, at the discretion of the director, may be admitted on the various services of the hospital. All hospitalized ward patients with a diagnosis of neoplasm or suspected neoplasm receive the benefit of consultation by the attending physician on service and the director of the Tumor Clinic. The therapeutic procedures are executed by the surgical attending staff, the Radium Department, or the X-ray Department, as the case may be. After discharge from the hospital, the patient reports to the Tumor Clinic for follow-up examinations.

Personnel.—The personnel necessary for the organization of a tumor clinic in a general hospital varies with the size of the institution, the proposed scope of activities, and the available funds. If a moderate endowment is available, there are obvious advantages in establishing the nucleus of the organization on a full-time basis.

The full-time staff of the Tumor Clinic

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

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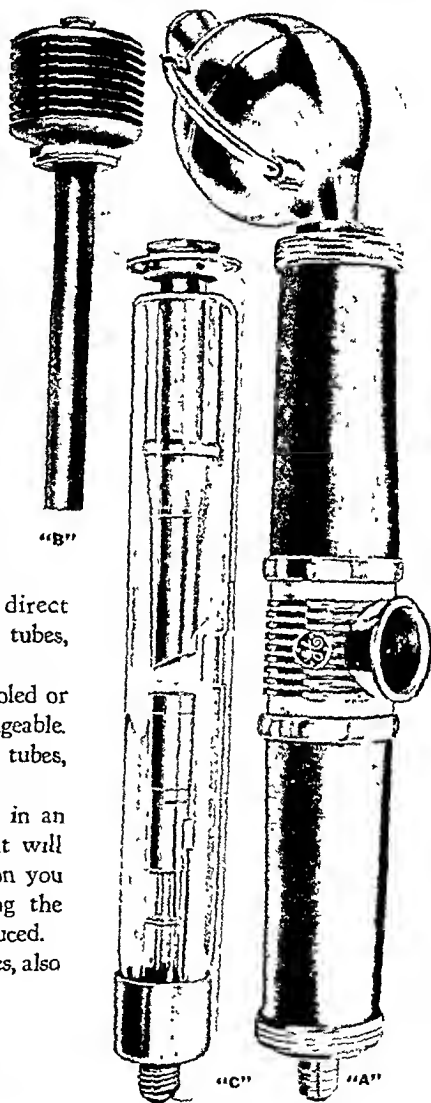
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of Columbia paste moulds, 25 tubes, each containing 5 mgm., are available for application to lesions of the skin and surface mucous membrane according to the Curie technic. These tubes are also employed in the Curie colpostat in the treatment of cancer of the cervix.

Six 25-mgm. tubes are designed for use in the treatment of cancer of the cervix and body of the uterus and for benign uterine and ovarian lesions (myomas, idiopathic uterine bleeding, etc.). The entire 500 mgm., or any available part of it, is utilized in the form of a small radium pack which is applied at a distance of 3 or 4 cm. for external radiation. This pack is useful in the treatment of neoplasms of limited size and depth, for example, recurrent tumors of the parotid, local recurrence of mammary carcinoma, etc.

The quantity of radium necessary in the establishment of a tumor clinic depends upon the number of patients to be treated. The Special Committee of the American College of Surgeons has determined upon 200 mgm. as a minimum requirement. If the Curie technic is employed, utilizing the principle of irradiation with small quantities over long periods, a carcinoma of the cervix can be treated with 60 mgm. of radium, the treatment lasting approximately five and one-half days. Assuming, for example, that 120 mgm. radium are available for the treatment of cancer of the cervix alone, the use of this technic would permit the treatment of 10 cases each month, or approximately 120 cases each year.

Radon.—The question of preference between radium element and radon is of considerable importance in the plans of organization and equipment of tumor clinics. In the special cancer hospitals in which large quantities of radium are available, a part of the radium is placed in solution and a portion is used in the form of the solid element. Assuming that all other factors, *i.e.*, the dose, filtration, and time of irradiation, are

the same, there is no proven or demonstrable biologic difference in the effects of radium element and radon. The only difference is that, whereas the intensity of radiation of

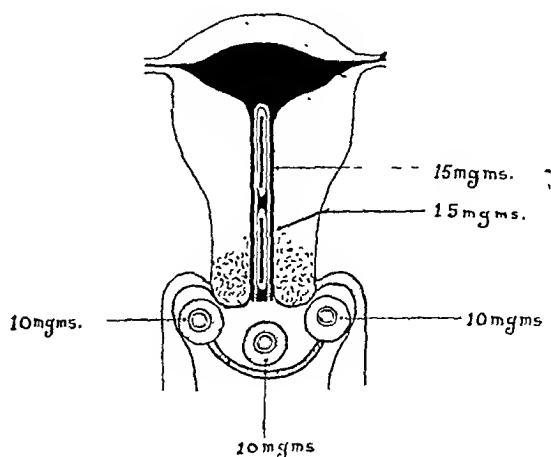


Fig. 3. Distribution of radium in the uterine canal and vagina in the treatment of carcinoma of the cervix. The vaginal applicator is the Curie colpostat. The filtration is 1 mm. Pt and the total dose between 6,000 and 7,500 mgm.-hrs. administered over a period of from 100 to 125 hours.

the element is uniform throughout the period of exposure, the intensity of radon is at a maximum in the beginning of treatment and at a minimum when the exposure is completed.

The preference for one or the other method is a matter of technic. Radon is more adaptable to experimental research in animals, both because of its flexibility and its security against loss.

Favoring the use of radium element over radon, Regaud points to the following advantages:

1. The protection of the health of the personnel. Radium element is usually enclosed in 0.5 to 1 mm. of platinum. With this filtration, there is less danger of injury from soft beta rays.
2. Complete absence of any loss of radio-activity.
3. Absolute equality in the radium content of the containers, permitting greater

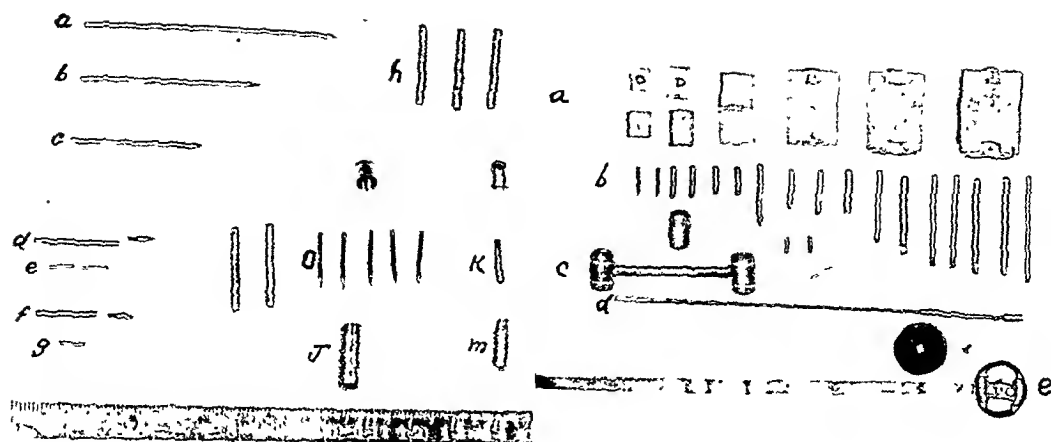


Fig. 1. Various types of radium element needles and tubes in the equipment of the Tumor Clinic. (a) Platinum-iridium needle 60 mm. in length, filtration 0.5 mm. Pt. containing 4.8 mgm. of radium element. (b) Platinum-iridium needle 44 mm. in length, containing 3 mgm. of radium element. (c) Platinum-iridium needle 32 mm. in length, containing 2 mgm. of radium. (d) Monel metal needle constructed to hold two removable 1-mgm. cells of 0.2 mm. Pt wall thickness. (e) Two removable cells of 0.2 mm. Pt wall thickness, each containing 1 mgm. of radium element. (f) Monel metal needle constructed to hold one 1-mgm. removable radium cell. (g) A 1-mgm. removable Pt radium cell 6 mm. long, 1 mm. diameter, and 0.2 mm. wall thickness. (h) 5-mgm. tubes contained in Pt tubes of 1 mm. wall thickness, having a length of 21.7

mm. and external diameter of 2.65 millimeters. (j) Platinum capsule of 1 mm. wall thickness designed to hold 5 monel metal needles, each containing 5 mgm. of radium element. (o) Five 5-mgm. monel metal needles 14.5 mm. in length, 1.25 mm. external diameter, 0.25 mm. wall thickness. (k) Monel metal tube having a length of 11 mm. and a wall thickness of 0.25 mm. containing 25 mgm. of radium element. (m) Platinum capsule designed to hold the 25-mgm. monel tube (k), wall thickness 1 mm. platinum.

Fig. 2. Various surface applicators, capsules, and other radium containers. (a) Surface applicators of varying sizes. (b) Brass, lead, and aluminum capsules for insertion into cavities. (c) The Curie colpostat. (d) Holder for 25-mgm. monel tube (e) Vaginal bomb.

in the Michael Reese Hospital consists of: director, assistant, resident interne, radium nurse, two radium technicians, and secretary.

The use of radium, especially when it is employed in the form of the element, introduces certain problems not within the scope of the nursing personnel in a general hospital. The custody of the radium from the point of view of safety, its distribution in various applicators, its sterilization and cleansing, require a special knowledge which the general nurse does not possess. A nurse especially trained to assist in the handling of radium and its application in the treatment of cancer is an indispensable addition to the personnel of a tumor clinic staff. The direct supervision of patients undergoing radium treatment and the nursing of post-radiation reactions are also cared for more safely and

efficiently by one specially familiar with these problems. A recognition of these facts has led to the establishment in the Nurses' Training School of the Michael Reese Hospital of a four months' post-graduate course for the purpose of equipping nurses with this special training and rendering them capable of assuming these responsible positions.

X-rays and Radium.—One high voltage X-ray machine is available for deep roentgen therapy. The Tumor Clinic owns 500 mgm. of radium element distributed among 124 containers. In the treatment of carcinomas of the tongue, breast, rectum, and other lesions in which interstitial radiation may be indicated, 70 platinum needles, varying from 1 to 5 cm. in length and 1 to 5 mgm in radium content, are employed. By means

efficiently performed in most general hospitals. The development of this aspect of the service and the perfection of technic constitute an important function of the tumor clinic staff.

Microscopic Diagnosis.—Recent clinical and pathologic investigations have established certain important relations between the microscopic appearances of tumors and their response to radiation therapy. Equally significant observations have confirmed the existence of certain tumors which possess characteristic morphologic appearances that are accompanied by an extremely unfavorable and usually hopeless prognosis in response to surgical therapy, but which are highly radiosensitive. The information that may be elicited from microscopic examination of biopsy specimens may, therefore, under certain circumstances, constitute an important guide in the choice of therapeutic procedures. Thus, anaplastic carcinoma of the fundus uteri is cured in a small percentage of cases by combined radiation and hysterectomy, but it is invariably fatal when hysterectomy alone is performed. Lympho-epithelioma and transitional-cell carcinoma of the tonsil yield about 30 per cent cures by radiation therapy, but none by surgical methods. Thus it is evident that an adequate pathologic report must contain information upon the anaplasia and radiosensitivity of the tumor.

Surgical Therapy.—General hospitals are usually adequately equipped with surgical facilities for executing all procedures in the surgical treatment of cancer. The results of surgery in the major forms of the disease vary with the training, skill, and experience of the surgical personnel. It is universally recognized and agreed that the surgery of cancer is a specialty and that the operative mortality, as well as the results, vary within wide limits. The concentration of surgical cancer cases of limited regions of the body in the hands of individual surgeons tends to develop competent specialists in

limited fields. This end can be best accomplished by a system of special assignments such as is practised in the Massachusetts General Hospital and in the Michael Reese Hospital. A definite improvement in results and lowering of operative mortality have been demonstrated in institutions in which this principle has been adopted.

Radiation Therapy.—It is not within the scope of this communication to discuss the details of the technic employed in the radiation treatment of cancer, but it may be of interest to state broadly the principles which dominate our radiotherapeutic procedures.

(A) *External Radiation.*—All cases in which radiotherapy has been selected as the method of treatment are divided into two categories: palliative and curative. The scheme of therapy is decidedly different in the two circumstances. When it is proposed to effect palliation, moderate exposures in divided doses are administered at intervals in an effort to induce growth restraint, reduce pain, and to prevent or control extension of the disease, ulceration, infection, and hemorrhage.

When the character of the lesion justifies an attempt to cure, the scheme of therapy is altogether different. We agree with Regaud that the most effective method is that which administers to the lesion a uniform, homogeneous, penetrating irradiation of an intensity sufficient to effect complete destruction of the tumor, and closely approaching, but not reaching, the tolerance of the surrounding normal tissues. The advantage of this scheme of therapy over prolonged and repeated irradiations appears to us to have been fully demonstrated.

The precise optimum period of irradiation has never been fully established. In the treatment of epidermoid carcinoma of the tonsil, hypopharynx, and larynx, Regaud and Coutard are of the opinion that the optimum period of irradiation with X-rays is between 14 and 21 days. It is highly probable that the excellent results obtained in

perfection in uniform intensity during surface irradiation.

4. The constancy of irradiation.
5. Ability to execute prolonged irradiation.

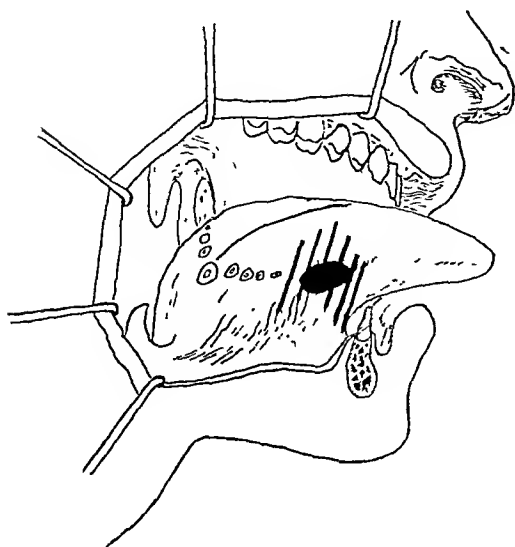


Fig. 4. Arrangement of removable radium element needles in the treatment of carcinoma of the tongue according to the technic of the Curie Institute. The filtration is 0.5 mm. of platinum.

tion without the necessity of recharging the tubes.

For these reasons, after a long experience, the therapeutic section of the Curie Institute has more and more restricted the use of radon and limited it to animal experimentation.

In the various cancer clinics in England, Belgium, and France, it is interesting to observe that, if both radium element and radon are available, there is a marked tendency to employ the element for clinical therapeutic procedures.

Radium Bombs.—The present state of our knowledge does not permit an absolute decision upon the efficacy of large quantities of radium employed in the form of a bomb in the treatment of deep-seated neoplasms. Highly radioresistant tumors that have failed to respond to high voltage roentgen-therapy have not yielded to treatment with

the radium bomb. On the other hand, experience with this method in some of the European centers has been more encouraging, particularly in the treatment of epidermoid carcinoma of the tonsil, pharynx and larynx, and parametrial extension from carcinoma of the cervix. It is also of interest to consider that the unique results of Coutard in roentgentherapy of carcinoma of the larynx, pharynx, and tonsil were accomplished by a technic designed to imitate the gamma ray of radium, both as to penetration and prolonged time of exposure.

The writer is of the opinion that these results can be duplicated and possibly improved by the use of a 4-gm. radium bomb with less constitutional effect upon the patient. In an effort to conduct further observations along these lines a 4-gm. radium element bomb, similar to that now in use in the Memorial Hospital, New York, has been installed in the Tumor Clinic of the Michael Reese Hospital.

IMPROVEMENTS IN SERVICE

Clinical Diagnosis.—The clinical diagnosis of cancer is becoming increasingly more difficult as the disease is encountered in its earlier stages. Accuracy in diagnosis is based upon extensive clinical and pathologic experience. By increasing and concentrating clinical material and by focusing interest and attention upon the recognition of early and borderline lesions, the organization of a tumor clinic results in accumulation of valuable experience by members of its staff and, consequently, an increase in the accuracy of clinical diagnosis and interpretation of early cancer.

Biopsy. Indications and Contra-indications.—The proper selection of the site and extent of the excision and the correct technic of biopsy, in order to avoid trauma and dissemination, are matters of the greatest importance in the diagnosis and treatment of cancer and upon the subsequent course of the disease, yet this important service is not

individual members of the staff through a system of special assignments promotes interest, concentrates clinical and pathologic experience, and facilitates study, research, and education.

5. An expression of expert opinion upon the choice between surgery and radiation in the treatment of benign and malignant tumors is of prime importance and constitutes the most valuable single service that the tumor clinic can render to the staff of the general hospital.

6. It cannot be too strongly emphasized that the success and efficiency of a tumor clinic can be only as great as the training and experience of the directing personnel. The outstanding obstacle to the rapid development and organization of tumor clinics throughout this country is the lack of adequately trained men capable of directing such units. It is most important, therefore, that special cancer and tumor clinics in the larger general hospitals include in the activities of their organizations a program of prolonged post-graduate training in the form of fellowships similar to those in the Memorial Hospital, New York City. Thus will younger men be equipped with thorough training and experience such as will render them capable of assuming directorship of the proposed cancer units or tumor clinics in general hospitals. This is an educational activity of prime importance in the problem of cancer control and one entirely worthy of financial support.

DISCUSSION

DR. F. C. WOOD (New York, N. Y.): Dr. Max Cutler has had the great opportunity of coming to a hospital with an endowment, the medical staff and managers of which desired that a cancer clinic should be developed. He has had the opportunity of seeing European technic and he has had long training at Memorial Hospital. He came ideally equipped with surgical and radiologic training to a new situation, which was also ideal.

I heard Dr. James Ewing say last year, at the College of Surgeons' meeting, that there should be established research institutes for cancer and that \$10,000,000 was a proper endowment. Ten million dollars for an endowment for an institute is a delightful sum but we can only dream of it as an ideal. It may come, but what are we going to do to-day?

Michael Reese Hospital is one of the finest in the country, but what are we going to do with a hospital in a relatively small town of fifty or a hundred thousand people, without much support? How are you going to help the cancer patient? That is the real question in this country. What is the radiologist going to do in a small hospital, without much money?

The first thing to do is to recognize the situation—that the surgical union is at present against the development of cancer clinics. The surgeons have been in a union since the time of Hippocrates. It does splendid work, cures many operable cancers, but it does not especially care about radiologists.

Send the surgeon all the operable cases. If you hand him all the operable cases, he will let you have the inoperables. How many of the cancer patients that come to your hospital is the radiologist going to get? About 90 per cent. The surgeon may think that 10 per cent more are operable. Give them to him. That leaves you 80 per cent.

I find that when I take a case to a surgeon and say, "This case is operable," the surgeon says, "Oh, no. No, you take him." But, if he thinks you are stealing cases from him, he comes down and says, "Here, let's abolish this department."

If you start that way, in the course of a couple of years your surgeons will be friendly, they will begin shifting cases down to you and saying, "You did pretty well with that one, better than I could have done. That's fine. He couldn't have had cancer."

That is the first answer. You have to prove from the pathologist's records that the patient did have cancer, but finally, in the course of a couple of years, you will have the confidence

this group of cases in the Curie Institute are due principally to the prolonged time factor. It should be noted, however, that the prolonged period of irradiation permits of the administration of a much greater dose than could be delivered during a shorter period. It is possible, indeed probable, that both these factors play a part in the favorable results that have been effected in this group of tumors.

The success attained by Coutard in the treatment of carcinomas of the tonsil, pharynx, and larynx by his special technic of roentgentherapy constitutes a most important advance in the radiotherapy of cancer, especially when it is considered that, in many of the cured cases, the lesions were fully developed, adult, squamous carcinomas of the most radioresistant type. The importance of manipulating the intensity, rate, and time of irradiation in an effort to induce a characteristic reaction in the tumor bed is fully justified by the results. In order to induce this reaction, the so-called "radio-epithelite" of Regaud, it is often necessary to administer a dose of sufficient intensity to cause a complete destruction of the superficial layers of the epidermis, or a so-called "radio-epidermite." When circumstances permit the use of multiple portals of entry, the intra-oral reaction can be elicited without the intense skin reactions that have been described.

(B) *Interstitial Radiation.*—In the treatment of carcinoma of the tongue, the writer is impressed with the advantages of the use of removable platinum needles over radon seeds. The superiority of the results by the former method is due mainly to two factors: the use of adequate filtration (0.5 mm. Pt) and uniformity of distribution of the radiation. The difficulty of distributing radon seeds uniformly throughout a tumor mass is perfectly obvious from studies of tissues removed after radium implantation. Even in the most experienced hands an uneven grouping of seeds is frequently un-

avoidable, resulting in areas of necrosis in foci which are over-irradiated by a group of radium seeds of inadequate filtration. The technical difficulty is distinctly less marked when removable platinum needles are employed. The same considerations apply to the treatment of carcinoma of the breast in which, on account of the great extent of the area involved, a uniform distribution is even more important and more difficult. In this connection I should like to state my position on the radiation treatment of mammary carcinoma. The available evidence does not justify the use of radiation alone in a strictly operable mammary carcinoma. The difficulties of deciding upon the presumable operability of mammary carcinoma by clinical examination are insurmountable.

SUMMARY AND CONCLUSIONS

1. Because of the exceptional difficulties involved in the treatment of cancer, a grave responsibility rests upon the trustees and staff of any institution that undertakes the organization of a tumor clinic, particularly in the choice of a competent directing personnel, adequate equipment, and perfection of organization.

2. Centralization of clinical and pathologic tumor material permits the assembling of information which exceeds the experience of any one individual, thereby raising the level of efficiency in the diagnosis and treatment of cancer in hospitals and in communities in which a well organized tumor clinic exists.

3. Free consultation and interchange of opinion on all cases before any form of treatment is begun give the patient the benefit of the combined experience of a group of specialists. They are particularly important since the initial procedure frequently determines the ultimate result. In no field of medicine is the intimate co-operation of a group so indispensable as in the treatment of cancer.

4. The allotment of groups of cases to

the Government; when the doctor wants to hear from them, he sends them a note saying that they are Government employees, and they have to come down and be seen. The Government gives the physician power to follow them up. All that is necessary is to send them a note. But Sweden is a little country and much is possible there that we can not do.

Do not play favorites in surgery. If you chance to be in central Ohio, and there is a fine surgeon in Cleveland who can do beautiful work in one line, why should not a patient in Columbus be told that he can get the best results in Cleveland? Your little clinic can send the patients where they can get the best re-

sults. Pretty soon one of your own young surgeons will ask the man in Cleveland to show him, and then your own will do the operating you want him to do and your cancer clinic will be more effective than before.

To my mind that is the whole backbone and explanation of a cancer clinic—you must furnish good diagnoses, careful and kindly treatment of your patients, and establish good relations with your surgeons and medical men. They will want to get rid of some of their cancer patients, so they will say, "Take them." At present, most cancer cases belong to the radiologist, but do not try to cure what some other man can treat more efficiently.

Million-volt X-ray Tube Begins Experimental Operation.—The new million-volt X-ray tube of the California Institute of Technology is being operated regularly and at a potential up to 1,200,000 volts. The research staff in charge of the large tube, headed by Dr. Charles C. Lauritsen, has made careful measurements of the intensity of the radiation produced and the limit of the length of short wave radiation has been determined by means of a specially designed crystal spectrograph.

In quantity of radiation produced the million-volt tube equals many times the amount of radium available for medical use in the world at present, the intensity being twenty roentgens at a distance of seventy centimeters from the target. This is equivalent, according to measurements made at the New York Memorial Hospital, to the raying power of at

least two kilograms of radium, which would cost at present prices about \$120,000,000.

The shortest wave length radiation produced is twelve X-units, which is less than most of that produced by radium.

Some research is now being done on the effects of the X-rays from this tube upon animals. The tube is to be used especially for biological work.

The million-volt tube is essentially a large and much modified edition of the conventional X-ray tube used in medical radiology but is operated with alternating current. In this it differs from tubes of lower voltages at the Memorial Hospital in New York City and at Schenectady. To supply the tube with current at a million volts potential, large transformers were built to order. These deliver sufficient current to light three hundred 100-watt lamps. —*Science Service.*

of the surgeons that you are not going to steal their patients from them.

You also have to convince the doctor or ordinary fellow who sends you cases that it is to his advantage to lose that case to you for treatment; you can do better than he can—the ointment fellow, the fellow who straps the breast, and the fellow who treats carcinoma with ultra-violet light. Show him he is going to lose more money in the long run by treating these cases improperly than if he refers them to this little beginning clinic.

In that little beginning clinic, the first thing is not brains, but a real human heart. Remember, everyone of those patients thinks he is going to die pretty soon. You have to conceal that from him. You have to have a cheerful place. Segregate the horrors from the others. Have them at a time when the other people can not see these terrible cases, or even smell them. You have to treat these patients with the utmost patience and care.

There is a lot of medical treatment you can do for a hopeless cancer patient—a little X-ray, some codeine, careful dressings, see about his food, see if you can help him in some way—let him know you are interested. Such patients have to be treated with the greatest kindness. They are the most pitiable people in the world because nobody wants to see them.

If you can begin to treat cancer medically and radiologically, pretty soon the surgeon will come downstairs and say, "Tell me what you are doing down here." Get the nose and throat men to come down and see a couple of larynx cases. Then if you do what Dr. Coutard has shown and Dr. Cutler talked about, if you have a good X-ray machine and you can get the fellow to stand it, you will get one-third of the cases of carcinoma of the larynx.

At Memorial Hospital, Dr. Cutler used to insert seeds. Now he goes to Europe and decides not to insert seeds. You cannot all visit Europe, but you can read Dr. Cutler's paper in *RADIOLOGY* and learn Regaud's method of not inserting seeds indiscriminately, but putting in needles of a particular sort.

The little clinic is not going to have \$100,000 worth of radium. It is going to have, perhaps, one X-ray machine. It may be run at only

150,000 volts. If that is so, do not sit and cry because you cannot go to 200,000 volts. You can help a lot of people with 150,000 or even 130,000 volts. The ordinary X-ray machine will bring a lot of comfort to patients with bone metastasis. You can not cure them as Dr. Pfahler can. They do not expect to live forever. If we can give them a year's life, two years' life, they may live longer than some of us will.

Meanwhile, you will not have any trouble with the little cancer clinic. Do not start too big. Begin slowly. Help a few patients. Pretty soon you will get everything in the hospital coming your way because you are doing good work, for the patients will talk about it. If you bring in the outside doctor and very quietly show him what he should have done and did not do, he will soon be sending you patients.

In a town of 100,000 you cannot expect to have an expert dermatologist, an expert ophthalmologist, an expert nose and throat man. But if you can get some younger men willing to be trained, willing to come in and see these cases, they can see more interesting material in your cancer clinic than they can see anywhere else, and gradually they will grow.

Finally, your clinic will feed back into your hospital a lot of interesting cases. If you get cases which you cannot handle, be perfectly frank about it and send them where they can be handled. That is the great factor—honesty. Face your limitations. We will never, for example, be able to cure more than a small percentage of carcinomas of the stomach, and the surgeons will be the only ones to do it. Do not try to cure cancer of the stomach with radiation.

If within fifty or a hundred miles there is a tenderhearted surgeon who will not charge poor people very much, railroad them to him. The cancer patient can always travel to get the best. The best cancer treatment in the world is carried on to-day in Sweden where the Government pays the patient's expenses to the Radiumhemmet, in Stockholm. After having received it, patients become obligated to



Fig. 1 March 28, 1931. Saucerized area in the tibia prepared for implantation of maggots. The sequestrum was extruded spontaneously during treatment.

Fig. 2. May 22, 1931. There is osteoplastic callus formation over the excavated area on the inner surface of the tibia, projecting into the soft tissues. The large medullary defect represents through-and-through perforation of the bone.

Fig. 3 Dec. 14, 1931. Contraction and condensation of the new-formed bone. Note the homogeneous eburation of the medulla. The perforation in the bone is closing. There is early reconstruction, and new cortex has formed on the anterior surface of the shaft.

sults and often, curiously enough, may extend beyond the involved area despite the absence of active infection.

A common method of treatment of medullary bone abscesses is evacuation by the use of the bone drill to establish a drainage channel. Roentgenographically this channel is easily detected. Healing is slightly different from that which occurs in the subperiosteal abscess. The medullary infection may be walled off by a dense eburnated border. If it is not walled off, regeneration of cancellous bone may begin in the abscess cavity first and then extend throughout the excavated channel. This is the most favorable result, since healing occurs simultaneously in the abscess cavity and in the drainage tract. Should the abscess cavity be large, or walled off, regeneration of bone in the drainage channel may occur before it does in the abscess. In this event a localized sterile vacuole in the bone may persist for years or else recur as an abscess. The question of the activity of the lesion may be extremely diffi-

cult to decide from the roentgenogram and, in most instances, it will depend solely on the local symptoms. In any event, the end-result of the drill operation is the creation of a sclerotic channel which may extend into a cavity representing the original abscess. The defect in the medulla persists for a considerable time. It is interesting to note that very little, if any, periosteal reaction occurs, despite the disturbance in its integrity. I have followed some of these cases for many years, and in practically all the sclerotic path of the drill can still be detected.

It is often possible to identify the method of treatment employed in massive osteomyelitic processes by close inspection of the X-ray plates.

The Orr method is employed to permit free drainage of the infected area. As the saucerization of the part is extensive, fractures are imminent and immobilization is accomplished by use of a plaster bandage. A roentgenogram of the area so treated is characteristic. Bone regeneration is slow

PECULIAR REGENERATION OF BONE, FOLLOWING MAGGOT TREATMENT OF OSTEOMYELITIS

By MAURICE M. POMERANZ, M.D., *Hospital for Joint Diseases, NEW YORK CITY*

THE recent investigations of Buchman and Blair (1) on the effect of maggot therapy in osteomyelitis afforded me an opportunity to study the roentgenograms of cases so treated.

The regeneration of bone in the diseased part is different from that which occurs in other methods of treatment and a description of it will be of interest to roentgenologists. In order to appreciate the significant variations, we must review the changes in bone as the result of an infectious process and the reaction of this bone to the hitherto accepted methods of treatment. We can then more fully appreciate the peculiar nature of the reaction following maggot therapy.

Infectious inflammatory lesions in bone may occur in the medulla, cortex, or periosteum, usually, however, in the medulla. The most important change is destruction involving the medulla, perhaps even the cortex. This is usually noted as a local area of osteoporosis or cancellous destruction involving the bone, usually at the site of the nutrient vessel supplying the segment. The size of the destroyed area will, of course, vary with the size of the vascular channel involved. If the main nutrient vessel is involved, the entire shaft may be destroyed. If a small terminal vessel is occluded, a localized area of necrosis (abscess) may be noted. The infection may then spread by means of the haversian canals to contiguous sections of bone, at times leaving islands of normal, uninvolved tissue. It is possible at this stage for multiple areas of destruction to be present. The pus may burrow through the canals, devitalizing the tissue and completely separating small segments of bone. If the infection occurs beneath the periosteum, it may burrow up and

down this sheath and elevate it, producing extensive periostitis. The cortex may, or may not, be involved. If it is, we have an osteoperiostitis. Occasionally, the infection becomes fairly well walled off and a localized subperiosteal abscess results. The new bone is deposited so that it may materially increase the diameter of the shaft, and it is important to remember that this increase is due to new bone deposit, and not to expansion. There is, however, retention of the general contour of the shaft. In chronic cases, reactive manifestations occur. These take the form of osteosclerosis, cortical thickening, or periosteal proliferation, usually combined to a variable degree. In the small bone abscess, a dense sclerotic wall may be produced; or, as sometimes happens, the earliest indication of a cortical abscess may be the slight periosteal reaction. The periostitis is usually rough and irregular, the bone being deposited in layers parallel to the long axis of the shaft. If the destroyed area involves the ends of long bones, direct extension into the joint and into all the bones of the joint may occur.

The process of bone regeneration is fundamental, but there is some difference in the manner in which the new bone is produced, depending on the type of treatment.

The procedure employed in localized bone abscesses is dependent on the site of the lesion. In the subperiosteal type, an incision over the bulging periosteum will evacuate thoroughly the infected area. The roentgenogram will show a slight erosion of the cortex with periosteal thickening. The defect in the cortex may quickly disappear or persist as a small punched-out area, the margins of which become well rounded with the passage of time. Periosteal thickening re-

VISCERAL DISPLACEMENT IN PNEUMONIA¹

A ROENTGENOLOGIC AND EXPERIMENTAL STUDY

By CHING WU, M.D., CHICAGO

From the Division of Roentgenology, Department of Medicine, University of Chicago

INTRODUCTION

MEDIASTINAL displacement and diaphragmatic elevation are commonplace findings in massive atelectasis and in certain phases of pulmonary tuberculosis, and physicians are beginning to realize that they may occur also in lobar pneumonia.

Van Allen and I (1) have reported several instances in experimental dogs. Thoenes (2) reported 11 cases of pneumonia, all showing displacement of the heart to the affected side. Wallgren (3) stated that he had frequently observed, in the pneumonias of young children, displacement of the heart to the affected side. St. Engel (4) considered elevation of the diaphragm on the affected side a common occurrence in lobar pneumonia. Griffith (5) reported displacement of the heart to the affected side in 16 out of 40 cases of lobar pneumonia in very young children. Coryllos and Birnbaum (6) reported mediastinal and diaphragmatic displacement toward the affected side in experimental pneumonia in dogs and stated that they frequently found the heart and trachea similarly displaced in human subjects. Hart (7) considered displacement of heart, trachea, and diaphragm toward the affected lung common in pneumonia.

The present communication deals with the roentgenographic findings relative to the diaphragm and mediastinum in 40 cases of lobar pneumonia admitted to the University of Chicago Clinics during the years 1928 to 1931 and in something over a hundred cases of experimental pneumonias in dogs.

¹In this study I have had the advice and assistance of Dr. Robertson, Dr. Hodges, and Dr. Coggeshall, of the University of Chicago



Fig. 1. Fifth day of lobar pneumonia involving almost entire left lung and part of right lower lobe. Accidental respiratory movements during filming show normal excursion of right diaphragm, left diaphragm completely obscured. Note heart displaced to the left until it is scarcely seen at all at the right of the spine.

published recently by Terrell and Robertson (8).

METHODS

The ideal roentgenographic examination in a study of this sort would consist of stereoscopic roentgenograms of the chest with the subject standing or sitting facing the films, plus fluoroscopic observation with the subject in the erect position. Obviously, however, most pneumonia patients cannot be submitted to such maneuvers.

Although Hodges and Robertson have conducted preliminary unpublished experiments which hold promise of allowing repeated routine fluoroscopy and stereoscopic roentgenograms of even the sickest pneumonia patients, these facilities are not available at present. Furthermore, most of the

and usually begins in the excavated area, gradually filling the defect produced surgically. This new bone is extremely dense and somewhat irregular in character. Reconstruction of a new cortex is not so characteristic as that which ensues after maggot therapy and periosteal thickening is often extensive.

The purpose of the Carrel-Dakin method is to disinfect the diseased area by means of a chemical solution after drainage has been established. The regeneration of bone following irrigation is extremely slow and somewhat irregular. Alternating patches of osteosclerosis and osteoporosis are common, and recurrences of the infection are not infrequent. The cortical and medullary thickening may be extremely marked. Occasionally, one sees linear calcification in the soft parts, probably due to irritation from the chemical, in the nature of a myositis ossificans or else to the actual deposit of the chemical in the soft part. This linear calcification is extremely uncommon in osteomyelitis except in cases treated by this method.

The roentgenograms of an infected area treated by the maggot method are fairly typical. The process of healing may be divided into three stages which are radiographically recognizable. -

The first, or exudative stage, is noted in from one week to 10 days, occasionally as early as six days, following saucerization. At this time, an osteoplastic process is noted which begins in the medulla, extending into the soft tissues immediately overlying the part. It does not extend beyond the excavated zone. While this material approximates the density, nevertheless it lacks the

homogeneity of callus. Its borders are well defined, and within the mass proper vacuolated areas suggest the formation of cancellous bone. This appearance persists for from two to four weeks, when the second, or contractile stage, is initiated. This stage is recognized by the contraction of the mass from the soft tissues down to the underlying bone, so that the approximate caliber of the shaft is re-established. As it contracts it appears to become denser so that it is as dense as the bone of which it is a component part. The new-formed tissue appears to fill in the gap produced by the saucerization. At this stage, there is no differentiation between medulla and cortex. The terminal, or reconstructive, stage is noted about six months after the operation. The excavated area is well rounded and the medulla is replaced by dense eburnated bone. I believe it perfectly conceivable that this eburnated bone will become replaced in its proper location by a new medullary cavity similar to that which occurs in old fractures of the shafts of long bones. Further condensation at the periphery of the shaft probably indicates the reconstruction of a new cortex.

Despite the limited period of observation of these cases, it can be stated that, following the maggot treatment, there is unusual regeneration of bone, resembling in its nature callus formation. It is also permissible to conclude that healing is more rapid and that the end product approximates more closely normal bone structure than any of the hitherto accepted methods of treatment.

REFERENCE

- (1) BUCHMAN and BLAIR: Maggots and Their Use in the Treatment of Chronic Osteomyelitis, Surg., Gynec. and Obst., in press.
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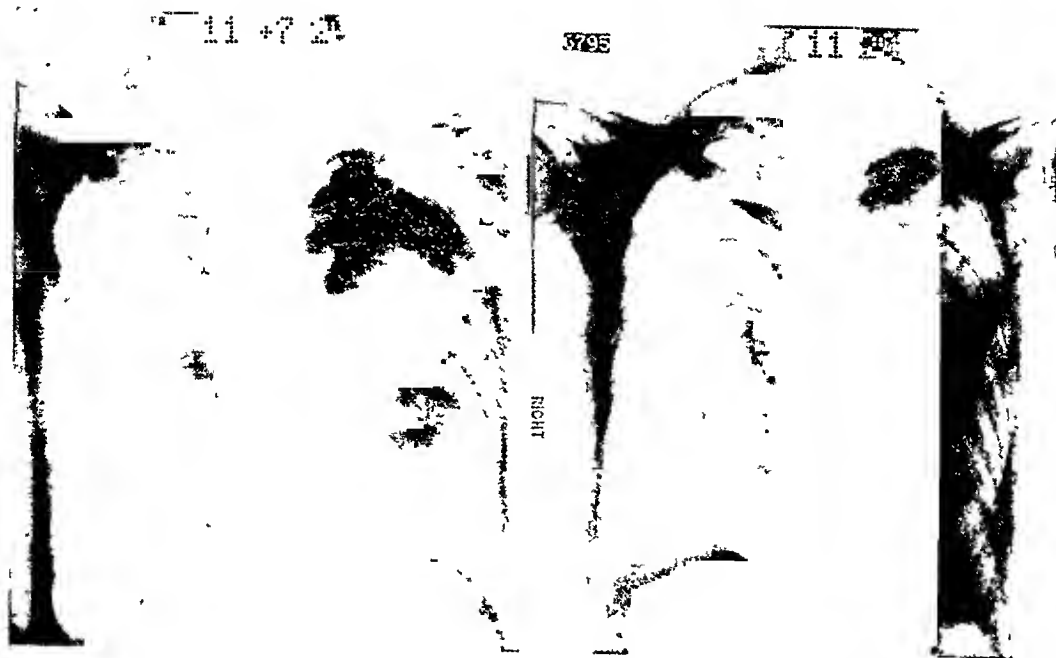


Fig 2-A—Third day of lobar pneumonia involving middle third of left lung. Note elevation of left diaphragm and displacement of heart to the affected side.

Fig 2-B Same case as shown in Figure 2-A. Fourth day of lobar pneumonia involving almost entire left lower lobe and part of left upper lobe. Note displacement of the mediastinum, including heart, to the left side.

films available had been made by others before I began my study so I had to be content with series of non-stereoscopic chest films made with the subject in the dorsal position in bed, positioned more or less carefully depending upon his condition and upon the skill and diligence of the roentgenology house-officer who happened to be on duty at the time the film was made. I have supervised the making of most of these films during the past six months (nine of the total number of cases) and I have taken care to position the patient with the sagittal plane of the chest parallel with the radiation—that is, with the patient in the true anteroposterior position, not rotated to one side or the other. Furthermore, I have made free use of the double-exposure technic reported by Jung and Van Allen (9) and subsequently reported independently by Thomas. Briefly, this consists of placing the film beneath the patient as if for an ordinary single chest

film, asking him to inhale, exhale, and then hold his breath in complete expiration. An X-ray exposure is made, the duration being three-fourths of the estimated full exposure. Without moving the patient or the film, the patient is told to take and hold a full breath, and an additional exposure, one-eighth of the estimated normal exposure time, is made.

ABSTRACTS OF CASES

Case 1 P. H., age 43 years, was admitted to the hospital on Jan. 7, 1930, following fever and chills of 24 hours' duration. On physical examination dullness over the left middle area posteriorly, diminished breath sounds and fine râles were noted. The roentgenogram showed a patch of density in the base of the right lung and complete consolidation of the lower lobe of the left lung.

January 8, 9, and 10—Roentgenograms

showed steady increase of the left lower lobe consolidation with a slight increase of the lesion at the base of the right lung. There was slight displacement of the mediastinum and the heart to the left. The left diaphragm was obscured by clouding of the left base.

January 11.—The right lung (Fig. 1) was clear except for a patch of consolidation at the base. The left lung showed complete consolidation from the apex to the base. There was seemingly frank displacement of the heart to the left.

Death occurred on January 14. Autopsy showed consolidation of the right and left lower lobes, with the lower two-thirds of the upper lobe in a stage of gray hepatization.

Case 2. E. Z., age 77 years, was admitted to the hospital on Nov. 6, 1929, following fever, anorexia, and a slight cough of two days' duration. Physical examination disclosed dullness with diminished breath sounds in the left lower lobe and râles in the left apex.

November 7.—The roentgenogram (Fig. 2-A) showed clouding in the middle third of the left lung. The left diaphragm was elevated and there was slight shifting of the heart to the left side.

November 11.—Diffuse clouding of the entire left lower lobe and slight graying of the upper lobe were seen (Fig. 2-B). There was displacement of the mediastinum and the heart to the left.

Death occurred on November 15. Autopsy showed a consolidated mass of the left lower lobe in a stage of gray hepatization.

Case 3. A. C., age 61 years, was admitted to the hospital on Jan. 5, 1930, following fever and pain in the right chest. On physical examination diminished breath sounds and bronchial breathing, right lower lobe, were noted. The roentgenogram showed

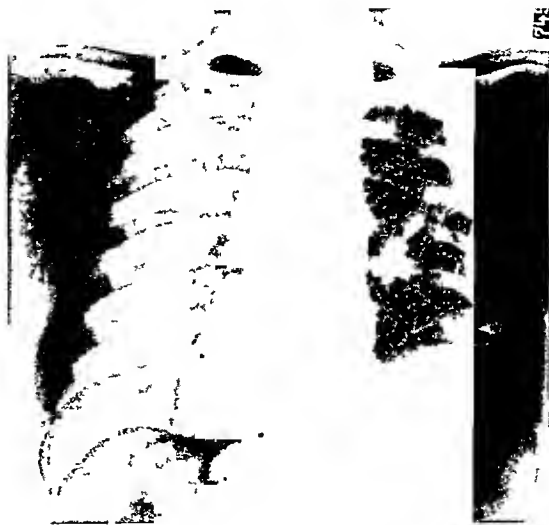


Fig. 3 Fifteenth day of resolving lobar pneumonia of right lung. Note marked elevation of right diaphragm and slight mediastinal displacement to the affected side.



Fig. 4 Seventh day of lobar pneumonia of left lung. Note displacement of the mediastinum, including heart, to the affected side. Left diaphragm slightly elevated.

definite clouding of the right middle and lower areas.

January 16.—There was frank clearing of the clouding in the right lung. The right diaphragm was markedly elevated, and there was slight displacement of the mediastinum and the heart to right (Fig. 3).



Fig. 2-A.—Third day of lobar pneumonia involving middle third of left lung. Note elevation of left diaphragm and displacement of heart to the affected side.



Fig. 2-B. Same case as shown in Figure 2-A. Fourth day of lobar pneumonia involving almost entire left lower lobe and part of left upper lobe. Note displacement of the mediastinum, including heart, to the left side

films available had been made by others before I began my study so I had to be content with series of non-stereoscopic chest films made with the subject in the dorsal position in bed, positioned more or less carefully depending upon his condition and upon the skill and diligence of the roentgenology house-officer who happened to be on duty at the time the film was made. I have supervised the making of most of these films during the past six months (nine of the total number of cases) and I have taken care to position the patient with the sagittal plane of the chest parallel with the radiation—that is, with the patient in the true anteroposterior position, not rotated to one side or the other. Furthermore, I have made free use of the double-exposure technic reported by Jung and Van Allen (9) and subsequently reported independently by Thomas. Briefly, this consists of placing the film beneath the patient as if for an ordinary single chest

film, asking him to inhale, exhale, and then hold his breath in complete expiration. An X-ray exposure is made, the duration being three-fourths of the estimated full exposure. Without moving the patient or the film, the patient is told to take and hold a full breath, and an additional exposure, one-eighth of the estimated normal exposure time, is made.

ABSTRACTS OF CASES

Case 1. P. H., age 43 years, was admitted to the hospital on Jan. 7, 1930, following fever and chills of 24 hours' duration. On physical examination dullness over the left middle area posteriorly, diminished breath sounds and fine râles were noted. The roentgenogram showed a patch of density in the base of the right lung and complete consolidation of the lower lobe of the left lung.

January 8, 9, and 10—Roentgenograms

showed steady increase of the left lower lobe consolidation with a slight increase of the lesion at the base of the right lung. There was slight displacement of the mediastinum and the heart to the left. The left diaphragm was obscured by clouding of the left base.

January 11.—The right lung (Fig. 1) was clear except for a patch of consolidation at the base. The left lung showed complete consolidation from the apex to the base. There was seemingly frank displacement of the heart to the left.

Death occurred on January 14. Autopsy showed consolidation of the right and left lower lobes, with the lower two-thirds of the upper lobe in a stage of gray hepatization.

Case 2. E. Z., age 77 years, was admitted to the hospital on Nov. 6, 1929, following fever, anorexia, and a slight cough of two days' duration. Physical examination disclosed dullness with diminished breath sounds in the left lower lobe and râles in the left apex.

November 7.—The roentgenogram (Fig. 2-A) showed clouding in the middle third of the left lung. The left diaphragm was elevated and there was slight shifting of the heart to the left side.

November 11.—Diffuse clouding of the entire left lower lobe and slight graying of the upper lobe were seen (Fig. 2-B). There was displacement of the mediastinum and the heart to the left.

Death occurred on November 15. Autopsy showed a consolidated mass of the left lower lobe in a stage of gray hepatization.

Case 3. A. C., age 61 years, was admitted to the hospital on Jan. 5, 1930, following fever and pain in the right chest. On physical examination diminished breath sounds and bronchial breathing, right lower lobe, were noted. The roentgenogram showed

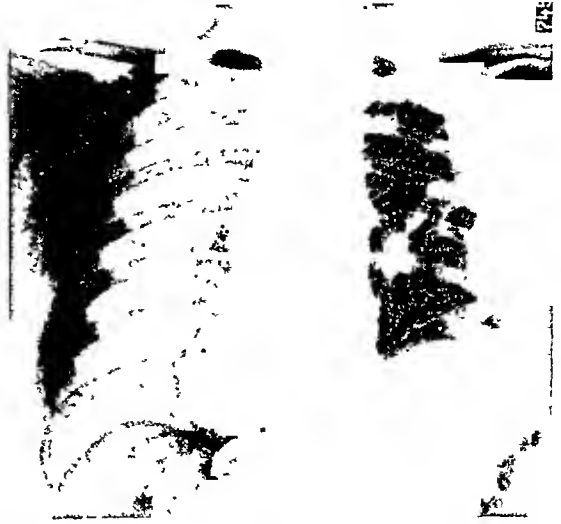


Fig 3 Fifteenth day of resolving lobar pneumonia of right lung. Note marked elevation of right diaphragm and slight mediastinal displacement to the affected side.



Fig 4 Seventh day of lobar pneumonia of left lung. Note displacement of the mediastinum, including heart, to the affected side. Left diaphragm slightly elevated.

definite clouding of the right middle and lower areas.

January 16.—There was frank clearing of the clouding in the right lung. The right diaphragm was markedly elevated, and there was slight displacement of the mediastinum and the heart to right (Fig. 3).



Fig. 5-A Eighth day of lobar pneumonia of right lung. Note marked elevation of the diaphragm on the affected side

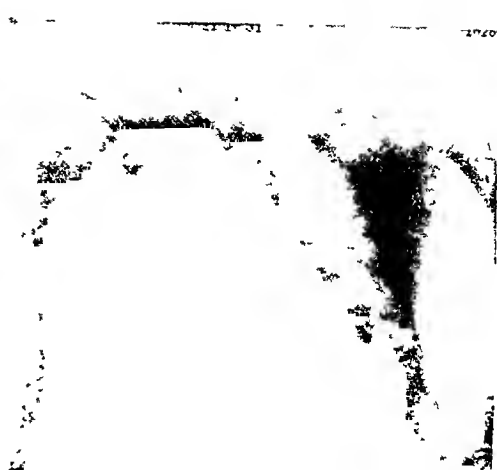


Fig. 5-B Same case as shown in Figure 5-A. Double exposure roentgenogram; shows free movement of the diaphragm on the normal side (*D-D'*) and very slight movement of the diaphragm on the affected side in the original X-ray film.

January 21.—There was practically complete resolution of the pneumonia of the right lung, but the right diaphragm was still higher than normal. The mediastinum had almost returned to its normal position.

Case 4. H. C., age 21 years, was admitted to the hospital on Jan. 1, 1931, following fever and cough of five days' duration. Physical examination revealed marked dullness and decreased breath sounds in the left chest.

January 2.—A roentgenogram (Fig. 4) showed diffuse clouding of the entire left lung. There was displacement of the mediastinum and the heart to the left. The left diaphragm was slightly elevated.

January 10.—The lungs were essentially clear. The diaphragm and mediastinum were normal in position.

Case 5. J. K., age 35 years, was admitted to the hospital on Nov. 14, 1931, with a complaint of having been ill for six days. On physical examination, diminished breath sounds were noted in the right lower lobe posteriorly.

November 16.—A roentgenogram (Fig. 5-A) showed marked elevation of the right

diaphragm and diffuse clouding of the right lung.

November 17.—A double exposure roentgenogram (Fig. 5-B) showed elevation and decreased excursion of the right diaphragm. The patient died on November 17; no autopsy was held.

Case 6. A. W., age 39 years, was examined on Oct. 24, 1931. The patient had had a temperature and complained of soreness in the left lower chest five days after operation for Hunner's ulcer of the urinary bladder. On physical examination, suppression of breath sounds and crepitant râles in the left lower chest were noted.

October 29.—A double exposure roentgenogram (Fig. 6) showed elevation and diminished excursion of the left diaphragm, with clouding in the left lower lung.

November 9.—There was practically complete clearing of the clouding in the left lung base. The left diaphragm had returned to normal position.

Case 8. R. B., age 40 years, was admitted to the hospital on April 8, 1930, following fever, cough, and soreness of the chest of five days' duration. On physical examina-

tion changes in the right lower chest were apparent. A roentgenogram showed slight graying in the right middle lung field and that the right diaphragm was elevated.

April 9 and 10—Roentgenograms showed

nias, and I have been able to do the roentgenographic work for them in approximately 20 of the more recent experiments. Their earlier films were made with the animal strapped to a board that has been described

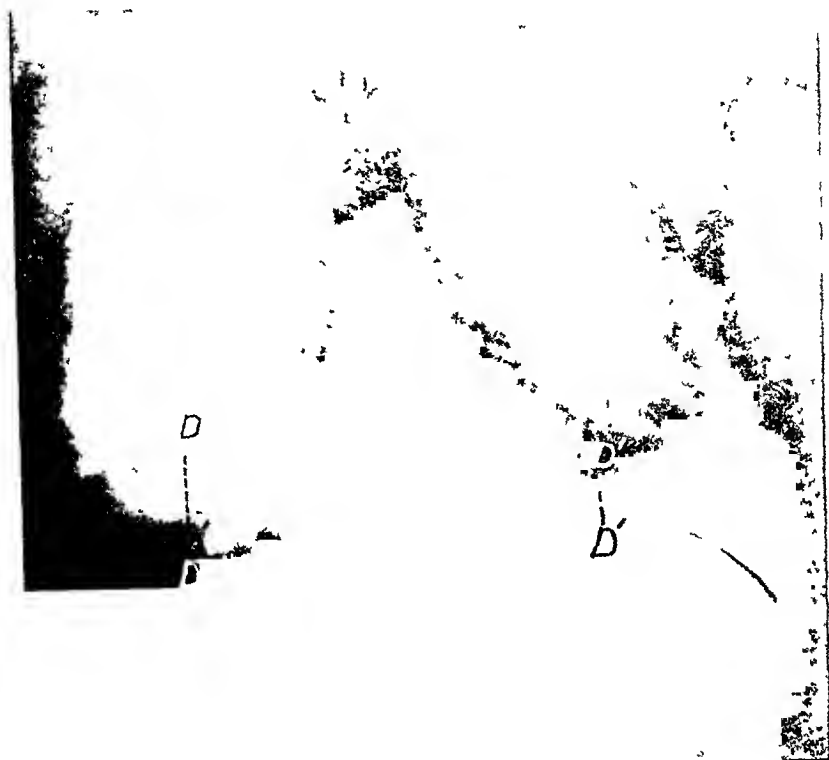


Fig 6 Double-exposure roentgenogram of post-operative pneumonia of left lower lobe. Note elevation and decreased excursion of the diaphragm on the affected side. Right diaphragmatic excursion measures 4 cm ($D-D'$). Left diaphragmatic excursion measures $1\frac{1}{2}$ cm ($D'-D'$).

marked clouding of the right lung and an elevated right diaphragm.

April 12—There was some clearing of the clouding in the right middle and lower areas (Fig 7). The patient breathed during filming and respiratory movements of the diaphragm were well visualized on both sides. The right diaphragm was elevated and moved with diminished excursion.

ANIMAL EXPERIMENTS

Terrell, Robertson, and Coggeshall have made available to me the X-ray films made in their large series of experimental pneumo-

by them, but I have employed a modification of their apparatus which I believe facilitates the orienting of the animal in the true recumbent position (Fig 8). The dog is placed on his back with his prominent spinal ridge lying in the trough of the aluminum window (*A*) and the telescopic side rails (*G*) are lengthened or shortened until the head fits the head restrainer (*D*). The forelegs are tied down to the line cleats (*B*) which have been so placed that the scapulae are drawn as far as possible away from the lung field. The hindlegs are lashed to the wooden posts (*F*). If the animal is restless,



Fig. 7. Fifth day of lobar pneumonia of right lung. Accidental respiratory movements during filming show diminished excursion and elevation of diaphragm on the affected side. The costal movements are well visualized on the sound side but are absent on the affected side.

a band of gauze is tied over the chest and around the board. Sighting along the prominence of the sternum, the examiner twists the animal slightly to the right or left until, in his judgment, the center of the sternum is perpendicularly above the spinous processes of the thoracic vertebræ. Formerly this alignment was facilitated by a plumb-bob (*E*), but experience has demonstrated that sighting with the eye results in sufficient accuracy.

The cassette (*C*) is now slipped into the tunnel beneath the aluminum window, the X-ray tube is brought into position perpendicularly above the center of the cassette, and an exposure made. The technical details, of course, vary somewhat, depending upon type of machine, photographic material, and the size of the animal. We have used approximately the following setting: target-film distance, 36 inches; tube current, 100 ma; tube voltage, 74 K.V.P.; filter, none; exposure time, one-twentieth of a second for small animals, more for heav-

ier ones; Eastman duplitized film; Patterson cleanable intensifying screens.

CHARACTER OF THE EXPERIMENTAL PNEUMONIA

The experimental pneumonias simulated quite closely the lobar pneumonia of man. The onset was sudden and the lesion was lobar in character, spreading from lobe to lobe. There was typical sustained fever, lasting from two, or three, to six, or seven, days, usually terminating abruptly. Examination of lung tissue demonstrated the presence of the main features recognized in human pneumonia.

INCIDENCE OF MEDIASTINAL AND DIAPHRAGMATIC DISPLACEMENT

Of the 105 cases examined, 42 showed some degree of mediastinal or diaphragmatic displacement to the affected side. Of these, 5 have been chosen to illustrate the phenomenon.

Case 1. Dog 14-D. The animal was small, weighing 14 kilograms.

Nov. 17, 1931.—At 8:30 A.M., the animal received an injection of 0.05 c.c. of Type I *Pneumococcus* culture into a bronchus of the right lower lobe. On November 19, in the morning, the animal was very sick and dyspneic, with a white blood count of 35,000 (12,000 normal for this animal).

Fluoroscopic Findings.—Lesion in the right lower lobe, and slight elevation of the right diaphragm, seen only on deep inspiration.

November 20.—The condition was unchanged. A roentgenogram (Fig. 9) showed uniform clouding of the right lower lung field and the heart slightly but definitely displaced to the affected side. At 11 A.M. the animal was killed, the trachea clamped, and autopsy performed.

Findings.—No pleural fluid. Right lung: Lower lobe had a liver-like appearance in consistency, and was completely consoli-

dated. The middle lobe showed alternate areas of consolidation and pneumatization; the upper lobe was normal. Left lung: Normal. Cultures and smears from the right lower lobe showed pure pneumococ-

of the right diaphragm and slight displacement of the heart to the affected side. The next day, the animal was very sick, coughing continuously. There was much sputum and nasal discharge, and difficult respiration;

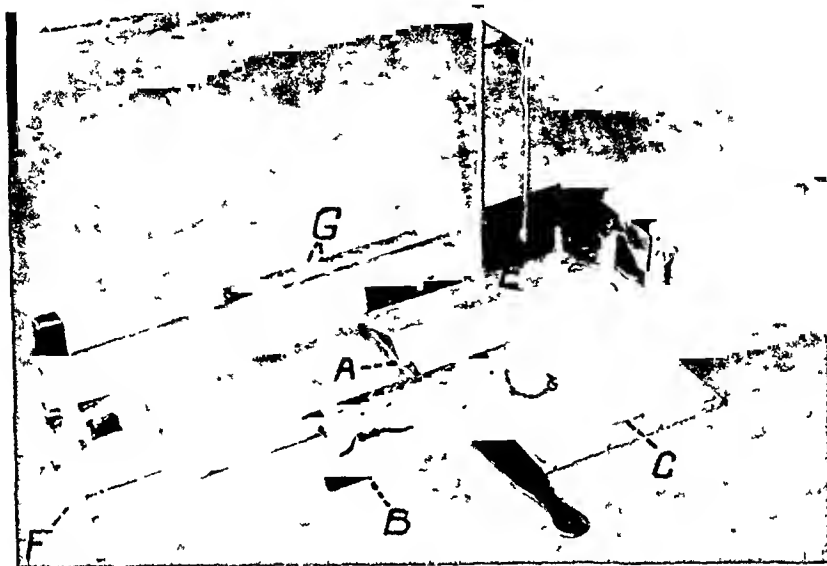


Fig 8 Special dog board (A) Formed aluminum window bent into a trough to receive the spinal ridge of the dog (B) Line cleats to hold forelegs (C) X-ray film cassette (D) Head restrainer (E) Plumb-bob (F) Wooden posts to hold hind legs (G) Peg which allows the lengthening or shortening of the telescopic sides of the holder to adapt it to dogs of various size

As first constructed, a plumb-bob was provided, but experience showed that this refinement was not essential since with the spinal ridge fixed in the trough of the aluminum window it was a simple matter to sight along the animal's sternum and position it correctly without the aid of the plumb-bob

cus; histologic examination revealed typical lobar pneumonia.

Case 2 Dog 21-D The animal, which was small, weighed 15.7 kilograms.

Dec. 7, 1931.—At 10:30 A.M., 0.06 c.c. of Type I *Pneumococcus* was injected into the right middle lobe bronchus. On December 8 the animal was very sick and dyspneic, with a temperature of 103.8° F., moderate coughing. Pulse rate, 168; white blood count of 10,000 (6,800 normal for this animal); blood cultures, no growth.

Fluoroscopic Examination.—Frank right middle lobe lesion with possible spread to the upper and lower areas; slight elevation

white blood count of 23,400; blood culture, negative; temperature 103.9° F.

On December 10, at 10:30 A.M., the condition was the same. A roentgenogram (Fig 10) showed displacement of the heart to the affected side and slight elevation of the diaphragm on the same side. The animal was killed at 2:30 P.M., the trachea clamped, and autopsy done.

Findings.—No pleural fluid. Right lung: The upper two-thirds of the lower lobe was of a liverish appearance and consistency. The lower one-third contained air. The middle and upper lobes were deep red and consolidated but showed air-containing areas



Fig. 7. Fifth day of lobar pneumonia of right lung. Accidental respiratory movements during filming show diminished excursion and elevation of diaphragm on the affected side. The costal movements are well visualized on the sound side but are absent on the affected side.

a band of gauze is tied over the chest and around the board. Sighting along the prominence of the sternum, the examiner twists the animal slightly to the right or left until, in his judgment, the center of the sternum is perpendicularly above the spinous processes of the thoracic vertebræ. Formerly this alignment was facilitated by a plumb-bob (*E*), but experience has demonstrated that sighting with the eye results in sufficient accuracy.

The cassette (*C*) is now slipped into the tunnel beneath the aluminum window, the X-ray tube is brought into position perpendicularly above the center of the cassette, and an exposure made. The technical details, of course, vary somewhat, depending upon type of machine, photographic material, and the size of the animal. We have used approximately the following setting: target-film distance, 36 inches; tube current, 100 ma.; tube voltage, 74 K.V.P.; filter, none; exposure time, one-twentieth of a second for small animals, more for heav-

ier ones; Eastman duplitized film; Patterson cleanable intensifying screens.

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The experimental pneumonias simulated quite closely the lobar pneumonia of man. The onset was sudden and the lesion was lobar in character, spreading from lobe to lobe. There was typical sustained fever, lasting from two, or three, to six, or seven, days, usually terminating abruptly. Examination of lung tissue demonstrated the presence of the main features recognized in human pneumonia.

INCIDENCE OF MEDIASTINAL AND DIAPHRAGMATIC DISPLACEMENT

Of the 105 cases examined, 42 showed some degree of mediastinal or diaphragmatic displacement to the affected side. Of these, 5 have been chosen to illustrate the phenomenon.

Case 1. Dog 14-D. The animal was small, weighing 14 kilograms.

Nov. 17, 1931.—At 8:30 A.M., the animal received an injection of 0.05 c.c. of Type I *Pneumococcus* culture into a bronchus of the right lower lobe. On November 19, in the morning, the animal was very sick and dyspneic, with a white blood count of 35,000 (12,000 normal for this animal).

Fluoroscopic Findings.—Lesion in the right lower lobe, and slight elevation of the right diaphragm, seen only on deep inspiration.

November 20.—The condition was unchanged. A roentgenogram (Fig. 9) showed uniform clouding of the right lower lung field and the heart slightly but definitely displaced to the affected side. At 11 A.M. the animal was killed, the trachea clamped, and autopsy performed.

Findings.—No pleural fluid. Right lung: Lower lobe had a liver-like appearance in consistency, and was completely consoli-

A roentgenogram (Fig. 12-B) showed heavy clouding in the right upper lobe, but the clouding in both lower lobes had practically disappeared. The mediastinum and the heart were displaced toward the right side in the upper area. The animal died on April 26, and autopsy was performed.

Findings.—No pleural fluid. Right upper lobe showed fairly even consolidation. Right and left lower lobes showed several small nodular consolidated areas. Smears from the right upper and both lower lobes showed pneumococci and small Gram-negative bacilli. Histologic examination revealed typical lobar pneumonia of the right upper lobe. The nodules of the lower lobes showed an atypical inflammatory process.

Case 5. Dog 20-B. The animal was small, weighing 10 kilograms. On Dec. 15, 1931, at 10 A.M., it received 0.35 c.c. of Type I *Pneumococcus* culture into the left lower lobe bronchus. On December 16 the animal appeared somewhat sick, and had a slight cough. The white blood count was 18,000 (7,800 normal for this animal).

Fluoroscopic Findings.—Lesion in the left lower lobe. Left diaphragm slightly elevated. The heart was displaced toward the left. A roentgenogram (Fig. 13-A) confirmed the fluoroscopic examination.

On December 17, the condition was much improved, the temperature was 102° F., and there was no cough. By December 19, the dog had completely recovered. A follow-up roentgenogram (Fig. 13-B), made on January 4, showed clear lungs and normal position of the heart and diaphragm.

ANALYSIS OF 40 CASES OF LOBAR PNEUMONIA IN HUMAN SUBJECTS

Of the patients, 37 were adults and three children. Of the cases, 22 show definite elevation of the diaphragm and five demonstrate some degree of displacement of the heart or mediastinal structures to the affected side. It seems possible to make the following generalizations:



Fig. 11. Case 3, Dog 2-C. Experimental pneumonia of right lower lobe 24 hours after injection. Note elevation of right diaphragm and slight displacement of heart to the right.

1. Diaphragmatic elevation and mediastinal displacement are to be noted only at full inspiration. At expiration, the findings are normal.

2. Displacement begins early, sometimes before it is possible to demonstrate consolidation, and persists usually throughout the course of the disease. It sometimes continues for a period after complete resolution has occurred.

3. Displacement is greatest and most regularly present when one entire lung is involved. It is less extensive and less frequent when the pneumonia involves only the lower lobe, and of slight degree or quite absent in simple upper lobe lesions.

4. In children and experimental animals, the heart or other mediastinal structures are apt to be displaced; in adults, most of the compensation is accomplished by the diaphragm.



Fig. 9. Case 1, Dog 14-D. Experimental pneumonia of right lower lobe 48 hours after insufflation, with slight displacement of heart to affected side.



Fig. 10. Case 2, Dog 21-D. Experimental pneumonia 72 hours after intrabronchial injection of Type I *Pneumococcus*. Partial consolidation of all of the lobes on the right, elevation of right diaphragm, displacement of heart to the right.

here and there. Left lung: The upper lobe showed several patches of consolidation. The other lobes were clear. Cultures and smears from the right middle lobe showed pure *Pneumococcus*. Histologic examination revealed typical lobar pneumonia in the stage of beginning resolution.

Case 3. Dog 2-C. The animal was small, weighing 9.4 kilograms. At 8:45 A.M., on June 15, 1931, the animal received an injection of 0.05 c.c. of Type I *Pneumococcus* culture into a bronchus of the right lower lobe. The following day, the animal was very sick, and respiration was labored. A roentgenogram (Fig. 11) showed even consolidation of the right lower lobe and the right diaphragm markedly elevated. There was slight displacement of the heart to the right. The animal was killed on June 18, the trachea clamped and autopsy done.

Findings.—Pneumonia of the right lower,

middle, and subcardiac lobes in the stage of beginning resolution. Histologic examination revealed typical lobar pneumonia.

Case 4. Dog 40-B. The animal, which was small, weighed 11 kilograms. On April 22, 1931, at 2 P.M., it received an insufflation of 0.03 c.c. of Type I *Pneumococcus* culture into the right upper, and both lower bronchi of the lungs, making a total dosage of 0.09 cubic centimeter. The animal looked sick the next day and the temperature was slightly elevated. The white blood count was 20,000 (11,000 normal for this animal). A roentgenogram (Fig. 12-A) showed slight clouding in the right upper and both lower areas. The heart and diaphragm were normal in position.

On April 24 the condition was the same.

TABLE I.—SUMMARY OF 40 CASES OF PNEUMONIA

Case no.	Unit no.	Name	Roentgenologic findings		Final clinical diagnosis
			Pneumonia	Visceral shift	
1*	18507	H. P.	W. L., R. L.	D., T., H.	Lobar pneumonia, Type IV
2*	16891	E. Z.	L. M., L. L.	D., T., H.	Lobar pneumonia, Type I
3	18425	A. C.	R. M., R. L.	D., T., H.	Lobar pneumonia, Type II
4†	49904	J. K.	W. R.	Diaphragm	Massive pneumonia
5†	42557	A. W.	L. L.	Diaphragm	Post-operative pneumonia
6	21542	R. B.	R. M., R. L.	Diaphragm	Lobar pneumonia, Type II
7	3193	M. K.	R. M., R. L.	Diaphragm	Lobar pneumonia, Type II
8	10778	H. L.	R. L.	Diaphragm	Lobar pneumonia, Type II
9	18748	A. L.	R. L.	Diaphragm	Lobar pneumonia, Type I
10	9624	A. M.	L. L.	Diaphragm	Lobar pneumonia, Type I
11	18273	H. M.	R. M.	D., T., H.	Lobar pneumonia, Type I
12*	6817	R. M.	R. L.	Diaphragm	Lobar pneumonia, Type III
13	21365	W. S.	R. M., R. L.	Diaphragm	Lobar pneumonia, Type IV
14	11423	F. V.	R. L.	Diaphragm	Lobar pneumonia, Type IV
15*	6340	T. F.	R. M., R. L.	Diaphragm	Lobar pneumonia
16†	47314	F. P.	R. L.	Diaphragm	Post-operative pneumonia
17	35300	E. C.	R. M.	Diaphragm	Lobar pneumonia, Type III
18	36001	S. T.	W. R.	Diaphragm	Lobar pneumonia
19*	48751	M. H.	B. L.	Trachea, heart	Pneumonia, hemorrhagic
20†	49210	M. E.	R. L.	Diaphragm	Lobar pneumonia, Type II
21	3971	A. Z.	R. L.	Diaphragm	Pneumonia, Type IV
22†	52695	M. R.	L. L., R. L.	Diaphragm	Lobar pneumonia, Type II
23	33971	A. P.	R. M.	Diaphragm	Lobar pneumonia
24	19487	T. A.	L. L.		Lobar pneumonia, Type I
25	10186	L. B.	L. L.		Lobar pneumonia, Type II
26	9136	S. H.	L. L., R. L.		Lobar pneumonia, Type III
27*	18620	V. C.	R. L., R. M.		Lobar pneumonia
28	10059	M. R.	L. L., R. M.		Lobar pneumonia, Type II
29	21212	B. G.	L. L.		Lobar pneumonia, Type II
30*	20033	N. H.	L. L.		Lobar pneumonia, Type IV
31	6429	K. H.	W. R.		Lobar pneumonia, Type III
32	10990	J. L.	R. U., R. L.		Lobar pneumonia, Type I
33	10367	M. M.	L. U., L. L.		Lobar pneumonia, Type II
34	12075	N. S.	L. L., R. M.		Lobar pneumonia, Type II
35	17747	F. T.	L. L.		Lobar pneumonia, Type III
36	8292	L. H.	L. L.		Pneumonia, Type IV
37	24810	C. B.	R. L.		Acute lobar pneumonia
38	30697	J. L.	R. M.		Lobar pneumonia, Type III
39	29237	B. H.	W. R.		Lobar pneumonia
40*	8763	E. K.	W. R.		Lobar pneumonia

Key to characters.—B. L.—Both lungs
 W. R.—Whole right
 W. L.—Whole left
 R. U.—Right upper
 R. L.—Right lower
 R. M.—Right middle
 L. U.—Left upper

L. L.—Left lower
 L. M.—Left middle
 D.—Diaphragm
 T.—Trachea
 H.—Heart

*—Clinical diagnosis confirmed by autopsy
 †—Double exposure roentgenogram

many workers (10, 11) believe that, in subphrenic abscess, the elevated diaphragm is distorted either by flattening or local bulging. Furthermore, they believe that the dia-

phragm is immobilized and that the lung above it usually shows some evidence of compression.

My assumption—that decreased volume

5. Neither mediastinal displacement nor diaphragmatic elevation is so regular or extensive in lobar pneumonia as it is in massive atelectasis.

pected of having pneumonia may show no pulmonary consolidation, but elevation of the hemidiaphragm on the suspected side may be the single clue to a small pneumonic



Fig 12-A Case 4, Dog 40-B Experimental pneumonia 24 hours after insufflation of Type I *Pneumococcus* culture into right upper and both lower lobes. Normal position of heart and diaphragm.



Fig 12-B Case 4 Forty-eight hours after injection. Marked clouding in right upper lobe. Displacement of mediastinum including heart toward the lesion. The distance between the cardiac apex and the diaphragmatic dome ($H'-D'$) had definitely increased as compared with the earlier film, apparently resulting from the pulling of the heart by the lesion in the right upper lobe.

DISCUSSION

It seems clear that, in the pneumonia of human beings as well as that of experimental dogs, the volume of the affected lung is smaller than normal at inspiration, as a result of which compensatory displacement of the mediastinum, or diaphragm, or both, occurs. In adults, it is usually the diaphragm alone that responds to the decreased lung volume; in children and dogs, the more flexible mediastinum participates in the compensatory contraction of the thoracic cavity.

A recognition of this condition may be of assistance in differential diagnosis. For instance, the roentgenogram of a patient sus-

patch hidden by the heart or by the dome of the diaphragm. Differentiation between pneumonic consolidation and pleural effusion is definitely simplified if mediastinal or diaphragmatic displacement can be demonstrated: in effusion, the displacement is away from the lesion; in pneumonic consolidation, it is toward the affected side. On the other hand, it is by no means an easy matter to differentiate between a diaphragm elevated because of the decreased volume of a consolidated lung and one pushed up by subphrenic abscess. In general, the elevated diaphragm of pneumonia presents a smooth upper surface and, though excursion is decreased, it is seldom entirely absent. But

It is, of course, a common autopsy observation that pneumonic areas do not expand on inflating excised lungs.

Coryllos and Birnbaum have assumed that massive atelectasis was present in these cases of pneumonia. It is true that atelectatic patches are sometimes present in the lungs of experimental animals (1, 12) and may possibly aid in producing some of the mediastinal and diaphragmatic displacement we have described, but it is our opinion (1) that they are at most of minor importance. We believe that an increased lung elasticity, due to thickening of the alveolar and lobar septa and pleural membranes, is the underlying factor.

SUMMARY

In 40 consecutive cases of lobar pneumonia in human subjects, mostly adults, five showed displacement of the heart and trachea to the affected side and 22 elevation of the diaphragm on the affected side. All of the five cases in the group studied by the double-exposure method showed diminished diaphragmatic and costal excursion on the diseased side. In 105 cases of experimental pneumonia in dogs there were 42 instances of visceral displacement.

CONCLUSIONS

1. The consolidated lung of lobar pneumonia has a higher elastic tension than normal; as a result, it expands less than the normal on full inspiration.

2. To compensate for decreased lung volume at full inspiration, there is usually some visceral displacement to the affected side.

3. In experimental animals or children, the mediastinum is the structure most active in compensating for decreased lung volume; in adults it is usually the elevated diaphragms that accomplish the compensation.

4. Roentgenographic demonstration of mediastinal or diaphragmatic displacement toward the affected side in cases of pulmonary disease is sometimes an important factor in differentiating between lobar pneumonia, pleural effusion, and certain other diseases.

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of the affected lung explains the diaphragmatic and mediastinal displacement of pneumonia—is somewhat at variance with

tention on the normal side is a simple mechanical result of increased elastic tension of the affected lung. Van Allen and I inflated



Fig 13-A Case 5, Dog 20-B Twenty-four hours after insufflation of *Pneumococcus* culture into left lower bronchus Displacement of the heart to the left and slight elevation of diaphragm on the affected side



Fig 13-B Same animal as shown in Figure 13-A Control roentgenogram taken 19 days after injection Disappearance of pneumonia in left lower lobe Heart and diaphragm have returned to normal position

certain views that have been expressed by others Thoenes, Wallgren, and Griffith believe that overdistention of the healthy lung is the cause In a sense this is true, though it seems probable that this overdis-

the excised lungs of a dog which had died of experimental pneumonia and found, as we expected, that, when pressure was applied to the trachea, the normal left lung distended much more than the consolidated right lung



Fig 14-A Both lobes collapsed the right pneumonic lobe is slightly larger than the left normal lobe

Fig 14-B Same lobes applied with equal pressure of air The pneumonic right lobe is much smaller than the normal left lobe

lished. In order to avoid loss of time, we, therefore, recommend that the intravenous method precede the retrograde method.

The secret of success in obtaining a greater number of readable films lies in the

the rubber bag, is placed, open side down, over the lower abdomen, about 4 inches proximal to the symphysis pubis. The long axis of the box, transverse to the long axis of the body, is held snugly in position by the

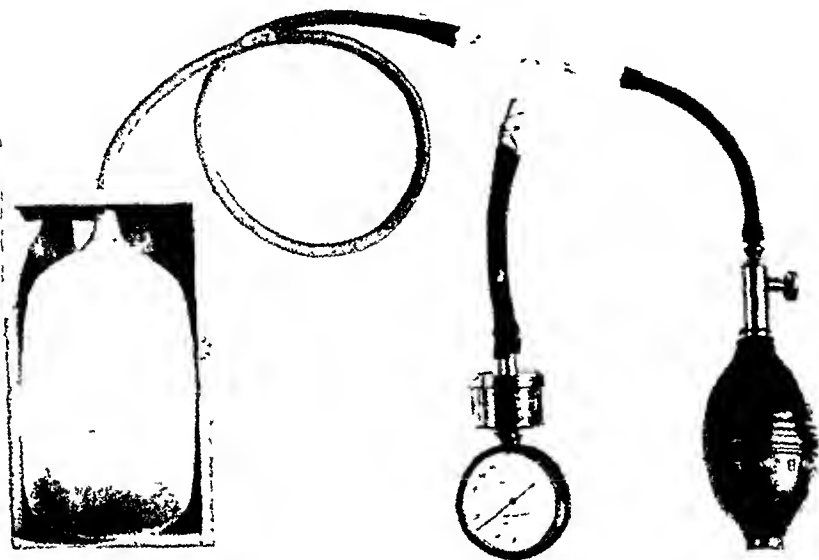


Fig 2 The several parts of the compressing apparatus

method of compression used before the X-ray exposure. The compression is applied over the lower abdomen at a point at which the ureter crosses the common iliac artery. According to Cunningham's "Anatomy," "The ureters lie in front of the termination of the common iliac arteries at the level of the intertubercular plane and about 1.5 inches from the median plane" (Fig. 1).

The apparatus used for compression consists of the following parts (Fig. 2):

1. A small wooden box, $5 \times 3 \times 1.5$ inches, with one side open
2. A small rubber bag, 4×2.5 inches, with a rubber tube attached to it.
3. A monometer, dial type
4. A rubber bulb, such as used in a sphygmomanometer.
5. A "T" glass connection.

The patient is in either the supine or the upright position. The wooden box, holding

compression band of the Bucky diaphragm. The three ends of the "T" tube connect, respectively, the rubber tube of the bag, the monometer, and the rubber bulb. The rubber bag is then inflated till a pressure of about 180 mm. of mercury is registered, the pressure being maintained for five minutes, after which an exposure is made. The entire urinary tract proximal to the compression is then invariably filled and a readable film is thus obtained. Another film is exposed immediately after the compression is removed. On the second film the urinary tract distal to the compression is visualized.

TECHNIC IN DETAIL, CHARACTERISTIC FINDINGS

The first film is taken before the injection. The exposure is made ventrodorsally with the patient in the horizontal posture on deep expiration. This film demonstrates

THE TECHNIC OF INTRAVENOUS UROGRAPHY

AN APPARATUS AND A METHOD OF COMPRESSING THE URETERS, USED IN 411 CASES

By JACOB ABOWITZ, M.D., Department of Roentgenology, Cedars of Lebanon Hospital,
LOS ANGELES, CALIFORNIA

THE diagnostic value of intravenous urography is at present still underestimated, due to the failure to obtain a greater proportion of cases in which the or anuria, very often the result of an acute renal colic or cystoscopy. In acute renal colic a good readable film is often obtained several hours after the injection of the drug. In

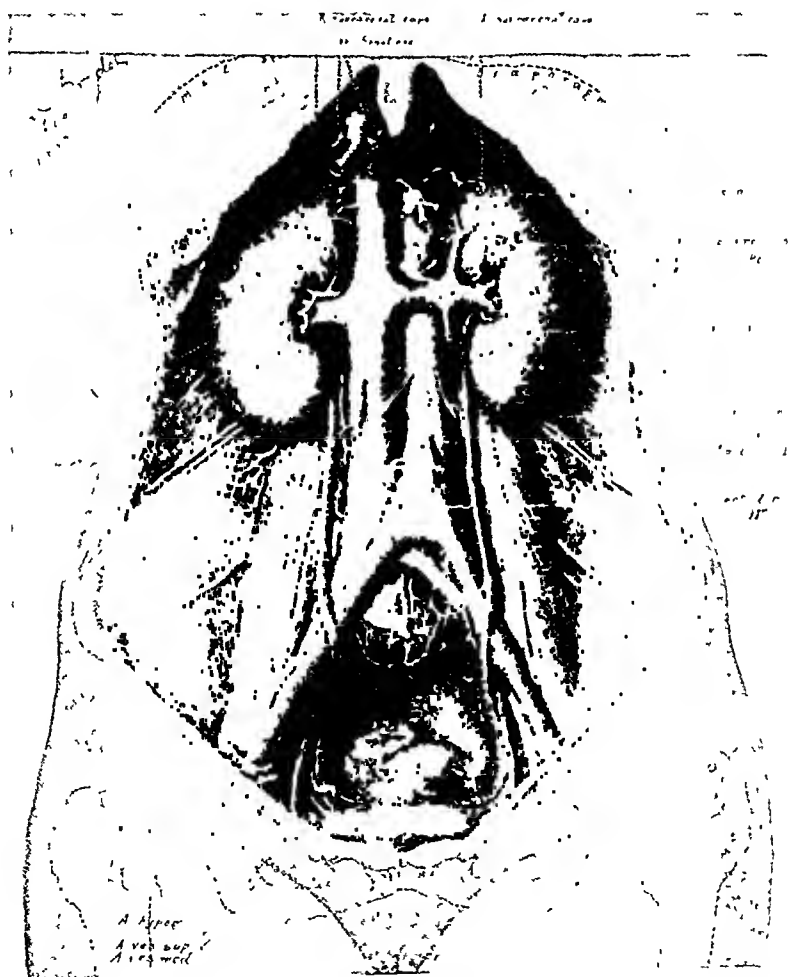


Fig 1 Showing the relation of the ureter to the iliac artery. The compression is applied at the point of crossing

urinary tract is filled and visualized on the film. The causes of the failure of filling of the urinary tract are either faulty technic

the case of cystoscopy, on the other hand, we postpone the injection for three days, or until the normal urinary excretion is estab-

lished. In order to avoid loss of time, we, therefore, recommend that the intravenous method precede the retrograde method.

The secret of success in obtaining a greater number of readable films lies in the

the rubber bag, is placed, open side down, over the lower abdomen, about 4 inches proximal to the symphysis pubis. The long axis of the box, transverse to the long axis of the body, is held snugly in position by the

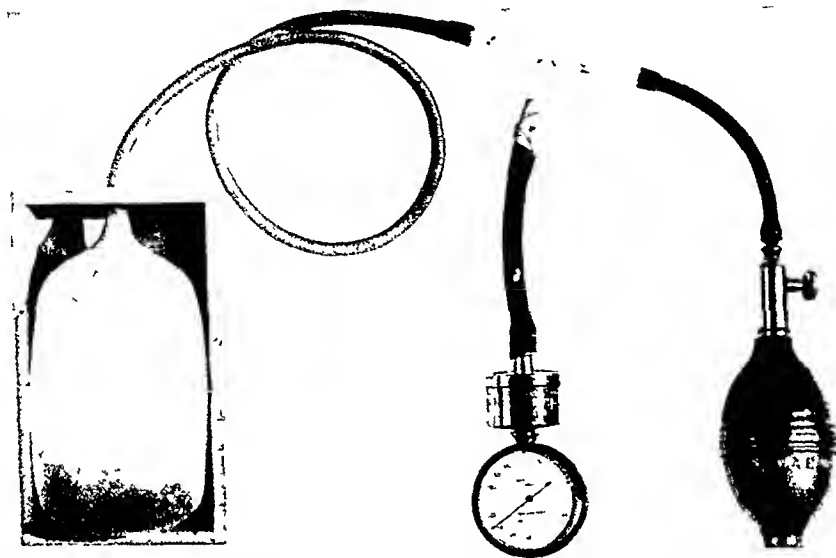


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The patient is in either the supine or the upright position. The wooden box, holding

compression band of the Bucky diaphragm. The three ends of the "T" tube connect, respectively, the rubber tube of the bag, the monometer, and the rubber bulb. The rubber bag is then inflated till a pressure of about 180 mm. of mercury is registered, the pressure being maintained for five minutes, after which an exposure is made. The entire urinary tract proximal to the compression is then invariably filled and a readable film is thus obtained. Another film is exposed immediately after the compression is removed. On the second film the urinary tract distal to the compression is visualized.

TECHNIC IN DETAIL, CHARACTERISTIC FINDINGS

The first film is taken before the injection. The exposure is made ventrodorsally with the patient in the horizontal posture on deep expiration. This film demonstrates

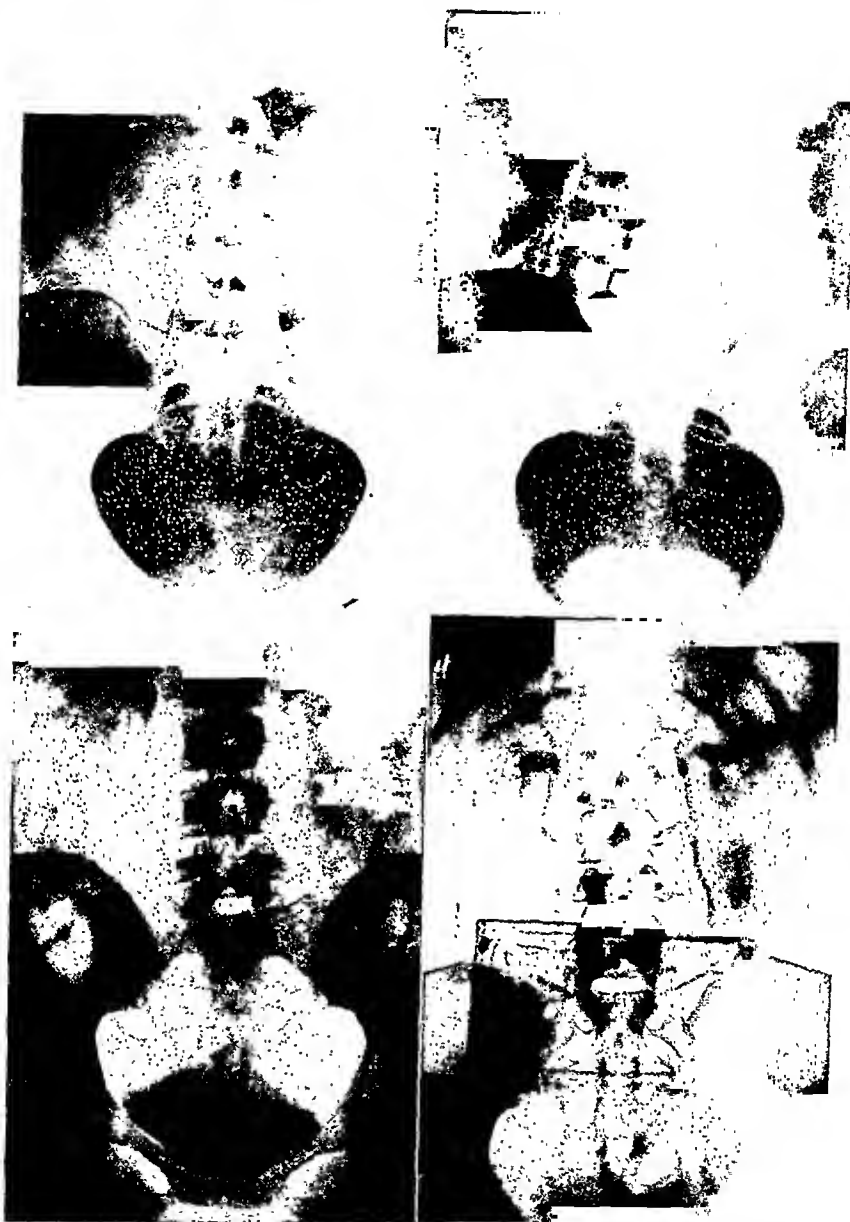


Fig. 3 (*Upper left*). Before the injection. Notice the calculus in the region of the right upper minor calyx, which might have been obscured by the excreted drug after the injection. This film also shows the position of the kidney during deep expiration.

Fig. 4 (*Upper right*). Five minutes after the injection. The film shows the appearance time of the excreted drug. Notice the increased intensity of the shadow of the renal pelvis on the right side, compared with that of the left. It is due to a partial obstruction at the ureteropelvic junction.

Comparing it with the previous exposure, the film also shows the position of the kidney on deep inspiration, or the excursion of the kidney during deep respiration.

Fig. 5 (*Lower left*). About 30 minutes after the injection. The urinary tract is more radiopaque. Notice the shelf in the urinary bladder, formed by the pressure of an enlarged uterus.

Fig. 6 (*Lower right*). Fourth film, taken in the horizontal posture, shows the compression apparatus *in situ*. Notice the filled urinary tract proximal to the compression.



Fig 7. Fifth film, taken immediately after the compression has been released, showing the filled ureters, distal to the compression



Fig. 8 Sixth film, with compression in the up-right posture. It shows whether or not a ptosed kidney can be raised by compression

existing calculi or calcareous deposits which may be obscured by the excreted drug. It also shows the position of the kidney during deep expiration. It is advisable that the patient remain on the X-ray table in the supine position during the injection and until the third exposure is made. Keeping the patient quietly in this position tends to keep the urinary tract filled (Fig 3)

Five minutes after the intravenous solution is injected the second film is made, on deep inspiration. It shows the appearance time, the difference in the intensity of the shadows of the excreted drug between one side and the other, and the position of the kidney during deep inspiration (Fig 4)

A third film is made 30 minutes after the injection, during suspended respiration. In addition to a denser shadow of the urinary tract, the film shows the outline of the filled urinary bladder. It often demonstrates

diverticula of the bladder, a thickened bladder wall, trabeculation, or an enlarged prostate. In the female, it shows extrinsic pressure on the bladder produced by adjacent pelvic organs. The size, shape, and position of the uterus and tumors of the uterus and adnexa are often recognized by the indentations they produce on a filled bladder. For that purpose we often make an additional film of the filled bladder in the up-right posture (Fig 5).

Before the fourth film is made, the patient is directed to empty his bladder. The exposure is made ventrodorsally with the patient in the horizontal posture and on suspended respiration. Compression is then applied before the exposure, as previously described. Besides visualizing the upper urinary tract, down to the point of compression, it shows the amount of residual urine in the bladder (Fig. 6).



Fig. 9. Film made after the patient had walked the floor several times. Notice the nephroptosis on both sides and the hydronephrosis revealed by the urinary stasis in the renal pelvis in the upright posture.

The fifth film, made immediately after the compression has been removed, shows the ureters distal to the compression (Fig. 7).

The sixth film is made with compression

similar to the fourth exposure, the only difference being that the exposure is made in the upright posture. This exposure demonstrates whether or not a ptosed kidney can be raised, by compression, to its original position (Fig. 8).

Before the last, or seventh exposure, the patient is directed either to walk the floor several times or to stand on his toes and come down forcefully on his heels to shake the kidney down, so that the degree of nephroptosis in the upright position is demonstrable on the film. The film, taken in the upright posture, also shows, in cases of hydronephrosis, the amount of urinary stasis in the pelvis and ureters (Fig. 9).

SUMMARY

1. The value of intravenous urography as a diagnostic procedure in the examination of the urinary tract is at present underestimated.
2. Among other causes of non-visualization of the urinary tract, poor technic is a great factor.
3. A workable technic and an apparatus for compressing the ureters is described.

Study Throws New Light on Tooth Decay.—The enamel which protects our teeth is made up of thousands of minute crystals of apatite, a kind of phosphate of calcium. In a dog's teeth these minute crystals are arranged perpendicular to the surface, while in human teeth they are inclined, according to findings of J. Thewlis, of the Physics Department, National Physical Laboratory, Teddington, England.

A dog's teeth are almost immune from caries. Chemically their constituents are identical with those of human teeth and possibly

it is their physical structure that gives them increased resistance.

To observe crystalline structure by means of X-rays a different method is used from that of the dentist who takes X-ray films to see the shape of the roots. The X-rays come from a point source; they strike at a known angle and are scattered in definite directions. The films obtained consist of dots and rings, and much mathematical sleuth work is needed to interpret them in terms of the arrangement of atoms and crystals.—*Science Service.*

THE SPECTROPHOTOMETRIC ANALYSIS OF THE COLOR OF THE SKIN FOLLOWING IRRADIATION BY ROENTGEN RAYS¹

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THE change in the color of the skin, that is, the production of erythema, has been used as an index of the dosage of roentgen rays since the realization that the tolerance of the skin for these rays is not unlimited. So far as is known, attempts have never been made to analyze accurately by physical means this change of color.

The usual conception of the roentgen erythema is that it is a gradually increasing redness, reaching a maximum on or about the fourteenth day, gradually declining thereafter with the coincident, or subsequent, development of pigmentation. Such a statement does not permit of a precise description of the color reaction and no one, from such a description, could reproduce a similar color.

In 1920, Seitz and Wintz concluded from their investigations that the roentgen erythema of the skin was satisfactory for use as a unit of standardization. They stated that the reaction in the normal skin varied only from 10 to 15 per cent with the same dose in different individuals. Leddy and Weatherwax disagreed with these observations, stating that the erythema, if taken as a unit, is flexible, arbitrary, and inaccurate. This statement has been substantiated by others (2) and is now generally accepted. Following the work of Failla with radium, Leddy and Weatherwax suggested the use of the threshold erythema as a unit in roentgen treatment if cutaneous erythema was to

be used. Threshold erythema is defined as the erythema which is produced from a dose of roentgen rays necessary to cause perceptible reddening in from seven to fourteen days in 80 per cent of subjects irradiated. Such a unit allows for normal variations, yet is, at the same time, rather definite.

Until recently, no attempt has been made to express the color of the normal skin in terms of its attributes, which are brilliance, or relative luminosity, hue, or dominant wave length, and saturation, or purity. Unless color is described according to its attributes, nothing definite is stated with regard to the color. It would seem that a more accurate description, other than clinical observation, of the change in the color of the skin following roentgen irradiation would be of value in outlining the course of the erythema. Such a problem entails consideration of some of the fundamentals of color and of the methods of analyzing color.

COLOR AND ITS ATTRIBUTES

Fundamentally, color is an impression produced on the observer when the retina is stimulated by light. Under varying conditions, a material will transmit or reflect a different amount of light. The source, quality, and intensity of light introduce variations. The most significant variable factor is the condition of the observer's color vision, particularly the presence, or absence, of color blindness. It is improbable that two individuals will react in the same degree to the same stimulus.

Various tintometric, or colorimetric, methods for the measurement of color have

¹The material in this paper was submitted by Dr. Harris to the faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Roentgenology. The work was done in the Division of Physics and Biophysical Research.

been developed. Such methods, which utilize color plaques made to certain specifications, are capable of being analyzed by the Munsell spinning disk or the Bradley top. These systems are open to the objection that they do not analyze the spectral colors reflected or transmitted from the material but use a set of arbitrary pigment standards. These standards have the further objectionable characteristic of fading with time. As in the direct observation of color, the personal factor enters, although the accuracy is greater. Such systems have been applied to the study of the color of skin by Rowntree and Brown, Freund and Novak (8, 9), and others, representing a valuable contribution to clinical medicine.

On the other hand, the spectral colors of white light can be measured easily and can be standardized. Any color of a given wave length, such as sodium yellow at 592 $m\mu$, is always the same and can be reproduced exactly. Not only do pigments vary in composition, but the light transmitted or reflected is not a pure spectral color, being a combination of different sets of wave lengths (20).

The report of the Committee on Colorimetry of the Optical Society of America (31) has greatly simplified the subject of colorimetric measurements. In this report, certain fundamental statements are set forth. Color is defined as the general name for all sensations arising from the activity of the retina and its attached nervous mechanism. Such activity, if the individual is normal, is nearly always a specific response to radiant energy of certain wave lengths and intensity. "Color cannot be identified with or reduced to terms of any purely physical conception; it is fundamentally a psychologic category." The spectrum is regarded physically as a graphic representation of radiant energy of certain wave lengths or frequency. The unit of measurement is the millimicron, a thousandth of a

micron, or a millionth of a millimeter. The Ångström unit (\AA .) which is frequently used, is one-tenth of a millimicron.

The human eye is sensitive only to a short range of radiant energy in the physical spectrum. This range is in the region lying between 400 and 760 $m\mu$, varying in the extremes with certain individuals. Beyond the red end of the physical spectrum lie the infra-red rays; their effect on consciousness is a sensation of heat. Beyond the violet end of the spectrum are the ultra-violet rays; their effect is realized by chemical or photo-electric reactions.

The color of any material depends on the absorption of certain wave lengths and the reflection or transmission of others. When one speaks of an object as being red, only the wave lengths in the red end of the spectrum (and certain others, according to Munsell) are reflected or transmitted, while the others are absorbed. When no light is reflected or transmitted and all is absorbed, the object is colorless, or black. If all the light is transmitted or reflected, the object is transparent, or white. If more or less equal proportions of all visible wave lengths are absorbed, the color is gray, or one of a series between black and white.

According to the work of Maxwell and others, all colors of the visible spectrum may be represented in terms of three primary colors: red, green, and violet. Such primary colors were considered by Young (1), as incapable of being matched by mixtures of any other colors. Pure spectral colors were obtained by the use of prisms and a source of white light. Later Maxwell showed by calculations that stimulation of one or more of the three sensations could account for all colors.

An adequate description of color can be made only by specifying it in terms of its three attributes. Such a specification takes the form of an immediate description of the color, without any reference to the stimulus.

Relative luminosity, or brilliance (brightness, value, tint, visual brightness), is that attribute of any color in respect to which it may be classified as equivalent to some member of a series of grays ranging between black and white. Brilliance, or relative luminosity, is absolutely necessary if color is to exist at all. Hue, or dominant wave length, is that attribute by which color is classified as reddish, yellowish, greenish, or bluish, differing in that respect from a gray of the same brilliance. Purity, or saturation, is that attribute which determines how different the hue is from a gray of the same brilliance. If a color has hue, it also has saturation, and *vice versa*; the two are interdependent. Hue is qualitative, while saturation is quantitative. Hue and saturation determine the sensation produced when "color" is used in the common and usual meaning of the word, gray and black being colorless by this definition. When hue and saturation only are taken into consideration, "chroma," as suggested by the Committee on Colorimetry of the Optical Society of America, is a better term than "color."

SPECTROPHOTOMETRY AND COLOR OF SKIN

Spectrophotometry offers a means of satisfactorily analyzing colors. It is the fundamental basis of all color specification (10) and the most accurate method available at the present time. The attributes of a color analyzed by the spectrophotometer are definite, describing the color absolutely and completely. By the use of a water-cooled cell, devised by Brunsting and Sheard (4), colors of living materials can be analyzed. Such a method of analyzing the color of the skin is final.

By spectrophotometric means, the attributes of color are determined independently of the condition of the observer's sense of color vision and independently of the source of light, provided this is sufficiently intense to make readings possible at the ends of the visible spectrum.

Sheard (27), and Sheard and Brown (28) were the first to use the spectrophotometric data supplied by the Committee on

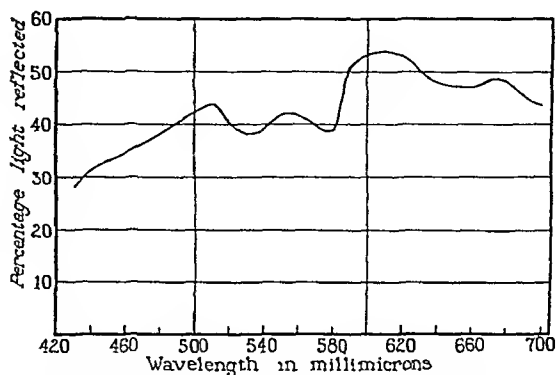


Fig. 1. Spectrophotometric curve obtained by reflection from the skin.

Colorimetry of the Optical Society of America to analyze the color of the skin. Their particular researches related to pathologic as well as to normal skin. In normal subjects, they found that the dominant wave length (hue), purity (saturation), and percentage red, green, and violet excitation values remained fairly constant, but that the values of relative luminosity (brilliance) decreased with increased amounts of pigment. They found the highest values of the relative luminosity in the skin of blond persons, the lowest values in the skin of the negro, with the brunette intermediate. Such a conclusion is almost self-evident, for a person with much pigment in the skin will not reflect as much light as one with only a small amount (30).

In numerical values, Sheard and Brown found the dominant wave length (hue) to be about 585 mμ, the purity (saturation) approximately from 40 to 45 per cent, and the relative luminosity (brilliance) between 45 per cent in the blond and 17 per cent in the negro.

Subsequently Brunsting and Sheard (5, 29) analyzed the color of the skin of blonds and brunettes and of persons of different races to determine the variations in color due to pigmentary content of the skin.

They found that the dominant wave length (hue) and purity (saturation) remained constant but that the relative luminosity (brilliance) decreased inversely with the amount of pigment in the skin. They found

in certain regions of the visible spectrum. Such zones of decreased reflection were more evident when the area of skin under consideration was congested; the minimums occurred in the regions 540 and 580 $m\mu$ and

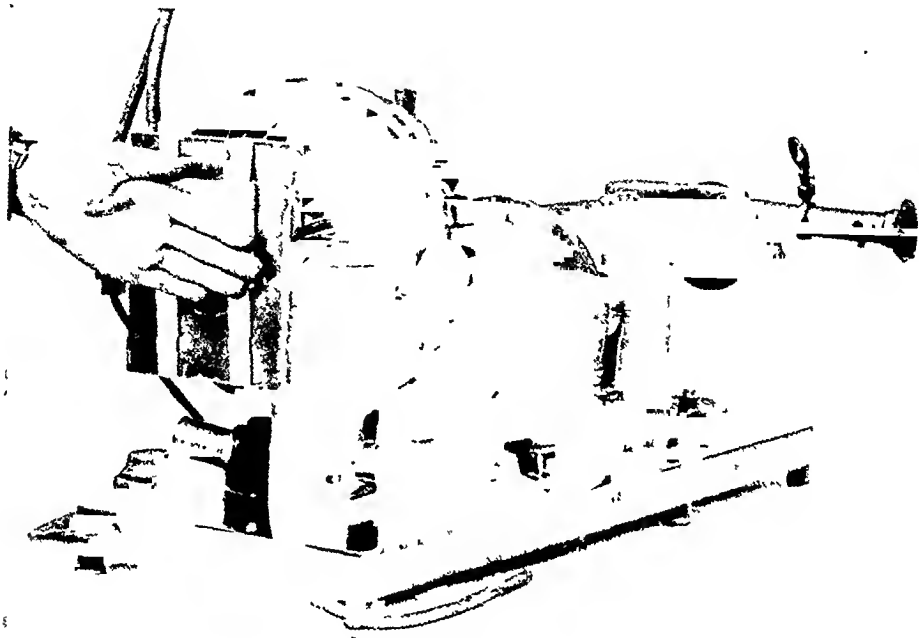


Fig 2 Spectrophotometer, or color analyzer, with water-cooled cell in position.

that variations in pigment did not affect the dominant wave length (hue) or purity (saturation). They found that the difference in color of the skin in different portions of the body depended only on the variations in relative luminosity (brilliance), except in exposed areas in which there was congestion of the superficial vessels. When the vessels were congested, the hue and saturation changed. They suggested that the pigment in the skin served to protect the underlying structures from excessive luminous energy.

In the portion of their work dealing with this phase of the subject Brunsting and Sheard (6) found that the blood in the superficial capillaries exerted a marked influence on the color of the skin. They noted a decrease in the percentage of reflected light

corresponded to the absorption bands of oxyhemoglobin (Fig. 1). As shown in two postmortem specimens analyzed after the blood was removed, these zones of absorption of light tended to disappear when the skin was devoid of blood. They also found that, when the skin was abnormal, an abundance of oxygenated blood near the surface caused a shift of the dominant wave length (hue) toward the red end of the visible spectrum (640 millimicrons). When a condition of cyanosis obtained, in which reduced hemoglobin predominated in the superficial vessels, the dominant wave length shifted toward the blue end of the visible spectrum (490 to 500 millimicrons). By spectrophotometric methods, they were able to detect changes in the color of the skin

when the hand was held above or below the level of the heart, thus showing the effects of anemia and congestion, respectively.

low, and *vice versa*) and that the difference in color of the skin of different individuals or races or different portions of the body

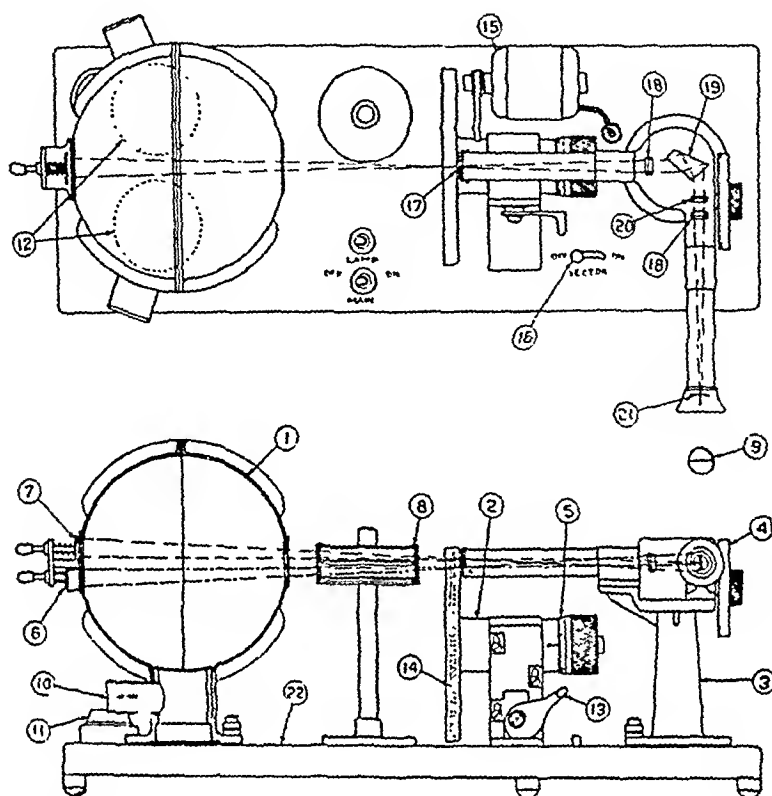


Fig. 3. Cross-sectioned diagrams showing the working parts of the spectrophotometer: 1, spherical lamp house; 2, photometer; 3, spectrometer; 4, wave length scale; 5, photometric scale; 6, holder for standard sample; 7, holder reflection samples; 9, field of view through the eye slit; 14, sector disks; 17, entrance slit; 19, dispersion prism, and 20, biprism.

From this work it is evident that the spectrophotometer furnishes the most satisfactory means of studying the color of the skin, that the dominant wave length (hue) of the skin is in the region of spectral yellow (580 to 590 $m\mu$), that the purity or saturation of this hue remains constant, that the relative luminosity or brilliance depends on the pigment content of the skin, that the changes in the red, green and violet excitation values vary in a linear fashion, with the percentage green acting as a turning point (that is, when the red is high the violet is

depends on the difference in relative luminosity (brilliance).

EARLIER WORK ON THE COLOR OF THE SKIN FOLLOWING ROENTGEN IRRADIATION

In considering the color of the skin following roentgen irradiation, there has been, as far as we could determine, no attempt to analyze the color except by direct visual observation. Therefore, no adequate description of the color or of the course of the color or its variations has been offered. No mention has been made of the attributes of

color in terms of hue, saturation, and brilliance.

A few months after Roentgen's announcement, in December, 1895, of the phenomenon bearing his name, there appeared

Holzknacht, in 1903, described a "premature reaction," occurring in some cases within from a few hours to a few days after exposure, then disappearing, to be followed by the "true reaction" on or about the elev-

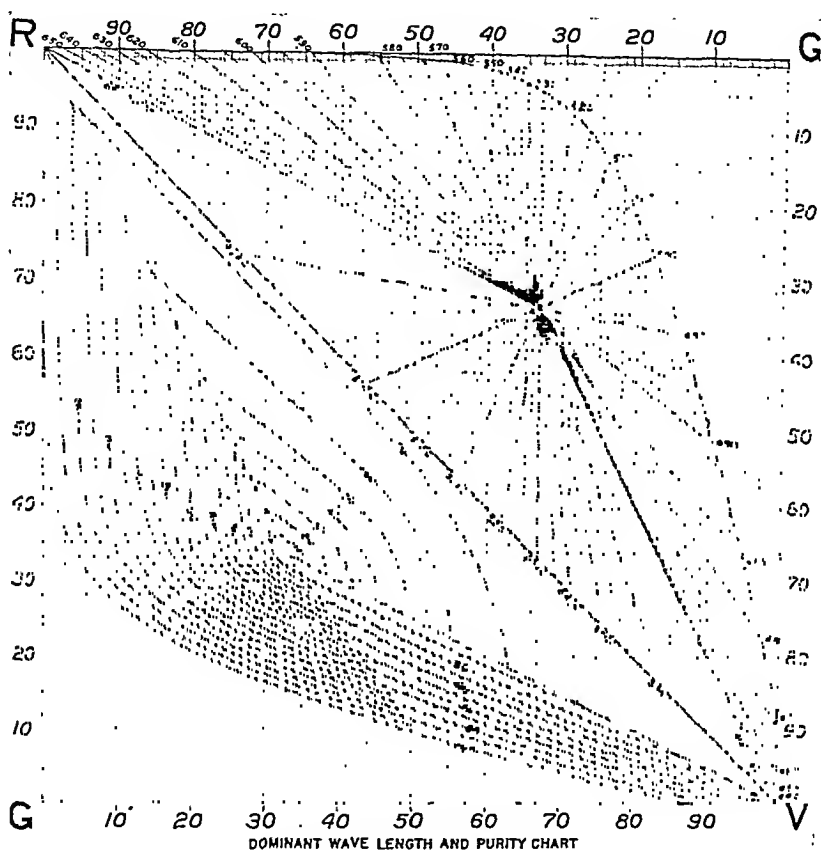


Fig. 4. Dominant wave length and purity charts from which the hue and the degree of saturation may be computed by the use of the data obtained from the values of the color excitations.

all over the world machines for generating roentgen rays. Since, at first, the small output of these necessitated exposures lasting for hours, it was not long before there appeared many reports of effects on the skin. Leppin was the first to describe these effects. As an engineer installing and demonstrating apparatus, his hands were exposed frequently, erythema developed, and the subjective sensation of heat was followed by thinning of the skin.

enth day. Holzknacht believed that this premature reaction was due to the roentgen rays and that it intensified the later occurring true reaction. Köhler, who was the first to describe the premature reaction, thought it due to heat waves from the tube. Schmidt considered that it was due to the ultra-violet waves from the tube and called the resulting pigment "pseudo pigment." In 1911, Brauer reviewed the subject and concluded that the reaction was part of the

true roentgen effect; that its intensity was proportional to the intensity of the roentgen rays, and that the pigment changes following it were due to an effect on the pigment itself.

From this earlier work it is evident that two portions of the roentgen reaction were known: an erythema occurring within one or two days, and another beginning on the fifth or sixth day and reaching its maximum on about the fifteenth day.

In 1923, Miescher (18), who answered in the affirmative his own question: "Is the roentgen reaction in the skin a rhythmic phenomenon?" described waves of erythema between eight and 22 days, 32 and 51 days, and after 58 days, respectively. In a much more comprehensive article, he described a complete experiment on the clinical determination of the course of the erythema due to irradiation with roentgen rays.

Miescher (19), who observed numerous patients, divided his technic into four qualities of rays, using on these patients five or six different doses of each quality of ray. He used an area 4×4 cm. on the thigh for a field. He then observed the skin reaction daily and recorded the changes in the color of the skin. His observations were made under as standard conditions as possible for the source of light, and so forth. They were, however, clinical observations of the difference of color of the irradiated area as compared to the surrounding normal skin. As a scale of the erythema he used R1, a slight redness, to R7, ulceration. The pigmentary changes he graded from P1, slight pigmentation, to P4, marked pigmentation.

Miescher's results showed a wave-like course of the erythema, with a wave occurring between the first and fourth days (average, two days). Another wave occurred between the eighth and twenty-second days (an average of 15 days). A third wave occurred between the thirty-fourth and fifty-first

days (an average of 39 days). He described the third wave as the most intense. His charts show the third wave to be the highest in value. The latent period between waves, which was apparent rather than real, tended to disappear with heavier doses. The crests of the waves tended to remain in the same time-relations, but were higher or lower according to the intensity of the dose. There were individual variations of from 15 to 20 per cent in the time-relation of the crests of the waves and from 40 to 50 per cent variation in the troughs. He found that the color of the skin or of the hair had no effect on the degree of the reaction. He observed a variation of 700 per cent in the different individuals between the slightest visible erythema (first degree reaction) and ulceration (a second degree reaction). He found that the curve of pigment followed the waves of erythema as a rule, although there might be more or fewer waves. At times the pigment followed only the third wave of erythema.

From this study it can be seen that the roentgen erythema follows a wave-like course. While he did not mention if there were more, Miescher described three waves of erythema. The fact that he placed the highest degree of reaction at the third wave suggests that there were more waves of erythema to follow.

This work has been confirmed by Pohle, who used a skin-capillary microscope to study the course of the erythema. Reisner and Neeff showed similar curves, using Miescher's method of recording results.

DESCRIPTION OF THE SPECTROPHOTOMETER

In our experiment, an attempt was made to show, by means of the spectrophotometer, the course of the erythema following a single dose of roentgen rays. The spectrophotometer used was the direct reading instrument developed by Keuffel and Esser and referred to as the "K and E color analyzer." The instrument was placed on the market

mainly for industrial applications, such as the grading of oils, estimating the concentration of colored solutions, detecting the nature of pigments in solution, the color of dyes, cloths, and paper, for the standardization of tinted glass and films, and so forth (Figs. 2 and 3). While a complete description of the instrument may be found in the literature, it may not be amiss to review the construction and principles.

A spherical lamp housing of cast aluminum, painted on the inside with zinc oxide paint, contains two 400-watt stereopticon bulbs. This ensemble serves as a source of white light which is constant during the course of the readings. Smooth blocks of magnesium carbonate at the rear of the sphere serve to reflect the light through various transparent media which are maintained in position in a holder placed between the sphere and spectrophotometer proper. If an opaque body, like the skin, is to be studied, the holder is shifted out of the path of the light.

Because of the rather intense heat developed by the incandescent bulbs, the color of living objects would tend to be modified. For this reason, Brunsting and Sheard devised a water-cell appliance which takes the place of the two blocks of magnesium carbonate and their holder. The water cell consists of a thin metal container through which water circulates, to keep it cool. There are two holes in the water cell, corresponding to the apertures in the light sphere, and of the same size. The lower aperture is covered with a thin metal plaque, painted on the inside with magnesium carbonate paint. This serves as a standard since it takes the place of a block of magnesium carbonate. The other hole serves to admit the light to the specimen to be examined. The side of the water cell toward the specimen is covered with felt, so that the cool surface of the metal is separated from the specimen and, hence, cannot affect the

color. The disadvantage of the extra centimeter of distance is amply made up by the advantage of keeping the specimen cool.

The two beams of light reflected from the skin and the standard, respectively, enter the spectrophotometer for analysis. The spectrometer is essentially an instrument of the ordinary constant deviation type, except that there is a biprism by which the visual field is divided into two symmetric halves, and an adjustable slit is provided in the observing end of the eyepiece. The desired wave length is obtained by turning a calibrated dial as shown in Figure 3. The amount of light entering the spectrometer may be varied by means of a rotating variable sector (the photometer) which is controlled by the calibrated drumhead shown in Figure 3. The light from the test object goes through the sector unchanged while the light from the standard is reduced in brilliance to that of the test object. The image at the observing slit consists of two semi-circular colored fields which have the same hue, this depending on the wave length only. Since the hue of the two fields is the same, the matching of the two fields is independent of the condition of the observer's color vision. Equality of brightness is obtained by rotating the drumhead on the photometer until an exact match is obtained. This reading, taken directly from the drumhead, is recorded as the percentage of light reflected from the specimen at the particular wave length for which the spectrometer is set. Throughout this experiment the entrance and exit slits were kept at a constant width. This was determined by using the light reflected from two magnesium carbonate blocks and adjusting the slits until there was 100 per cent reflection from the two blocks.

In making the readings, the portion of the skin to be examined was placed flush with the water-cooled cell. The actual readings were made by turning the calibrated wheel (Fig. 3) through a distance corresponding

to 10 millimicrons. The percentage of light reflected at each wave length was obtained directly by turning the drumhead (5, in Fig. 3) until an exact match of brilliance was achieved. From the data obtained, a spectrophotometric curve was plotted using the wave lengths as abscissæ and the percentages of reflection as ordinates (Fig. 1). From such a spectrophotometric curve, an experienced observer can determine certain characteristics of the object under consideration by studying the form of the curve in certain spectral regions. Since the spectrophotometric readings measure the spectral distribution of color and so measure the stimulus, they are independent of the condition of the observer's color vision. All observers, therefore, should obtain the same experimental results. Spectrophotometric measurements are independent of the character of the light, provided it is intense enough. This is a great advantage over color matchings by direct vision.

CONVERSION OF SPECTROPHOTOMETRIC DATA INTO TERMS OF COLOR VISION

In order to convert the curves of spectral reflection or transmission into a form to be interpreted directly into the attributes of color, it is necessary to make certain computations based on the theory of three-color mixtures as a form of color specification. This theory is probably the most fundamental of all concepts regarding color (26). It represents the law of three-color mixture and can be represented graphically in terms of red, green, and violet excitation values spread on an equal energy spectrum and referred to average noon sunlight illumination. The principal developments regarding these relations were made by Maxwell, Abney, König, and Dieterici.

The spectrophotometric data, obtained as direct readings from the color analyzer, may be translated into hue, saturation, and brilliance. It is necessary that such readings

be combined with a certain energy distribution representative of the particular source of light by which the object is viewed. This can be disregarded in the particular instrument used, as the energy distribution of the two tungsten filament lamps is practically the same as average noon sunlight. The report of the Committee on Colorimetry of the Optical Society of America (31) furnishes the following information:

(A) Multiply each of the ordinates of the transmission or reflection curve by the corresponding ordinates of the energy distribution curve of the source.

(B) Multiply each of the ordinates of the resulting curve by the corresponding ordinates of each of the color excitation functions, as given in Table I ('Excitations'), this being a separate operation for each of the three excitations, yielding three separate curves which represent the respective excitation values for each wave length of the given stimulus.

(C) Determine separately the areas of the three curves thus found. This latter operation can be performed by applying a planimeter to a graph of the resultant curves or—with sufficient accuracy—by finding the sum of representative ordinates of each curve, taken separately at uniform, small intervals such as 10 $m\mu$ —throughout the range of the curve in question.

(D) Reduce the three areal values thus obtained to percentage form, so that their determined ratio remains unchanged but their sum becomes equal to 100. The color excitation values can now be expressed by means of two numbers, representing the red and violet excitation percentages, that for the green being obtainable by subtracting the sum of these two values from 100.

The dominant wave length and purity may be determined from Figure 4, by applying the values of the red and violet excitations obtained from an analysis of the spectrophotometric data.

The conversion of spectrophotometric data as described in the foregoing paragraph may be accomplished more rapidly and more

simply by means of a special slide rule adapted to this purpose by Keuffel and Esser. The rule is used as follows: the slide is set at the percentage of light reflected at a given wave length (the reading taken from the calibrated drumhead, 5, of the photometer in Figure 3). The line is then set at the given wave length marked on the rule for red, green, violet, and relative luminosity values and the proportionate values read off the slide and tabulated. This is repeated for the 28 readings from 430 to 700 millimicrons. The resulting columns of figures are added. The totals for the red, green, and violet values are then reduced to percentage form so that their sum equals 100. The total for the relative luminosity values (in units) is put in percentage form; 10.4104 units are taken as 100 per cent, since this number of units represents the total relative light (as average noon sunlight) reflected from a pure white surface.

THE COLOR OF THE SKIN FOLLOWING A SINGLE EXPOSURE TO ROENTGEN RAYS AS ANALYZED BY THE SPECTROPHOTOMETER

This experiment was undertaken for the purpose of determining, as accurately as possible, the course of the roentgen erythema. The subjects used in this experiment were selected from among the Fellows and technicians. An area 8×8 cm. on the lateral aspect of the left leg was selected for irradiation. The area was large enough to get a nominal amount of back-scattering. So that all the areas might be the same size, a hole 8×8 cm. was cut in a piece of lead rubber. The rubber was then faced with 1 mm. lead sheet and the whole was bound with adhesive tape. Homologous areas on the calf of the leg were selected because of convenience and also because they presented, for the size of the field involved, a fairly flat and uniform surface.

The factors of exposure were as follows:

the potential across the tube was 135 K.V. peak value as measured by standard spheres. The current, which was 5 ma., was measured by two instruments. The focal skin distance was 40 centimeters. A Coolidge universal broad focus tube, of the type employed in treatment by moderate voltage, was used. The exposure time was 21 minutes. The output of radiation at this setting was 25 r per minute. The total dose to the areas was 525 r, measured in air. The area received no further exposure during the course of the experiment. The dose used has been found clinically to cause threshold erythema; that is, slight redness in 80 per cent of cases. The quality of the rays was as follows: the effective wave length by Duane's formula for 2 mm. aluminium was 0.31 Ångström unit. The half value layer in aluminium was 6.1 millimeters.

Spectrophotometric readings were taken immediately before irradiation and every day, as far as possible, after irradiation. In one instance (subject H. R. C.) the first reading was made three hours after irradiation.

No particular effort was made to protect the irradiated skin. It was desirable that the conditions following irradiation should be as nearly as possible the same as after therapeutic irradiation. The work was done in November and December so that the factor of sunburn did not enter into the experiment.

The adjustment of the spectrophotometer was not changed during the readings, which took place during from fifty to fifty-five days. The spectrometer was checked twice with a sodium flame to determine the correctness of the wave length scale setting.

The relative luminosity values (or brilliance) were used as a determinant of the pigment content (tanning) of the skin. As Brunsting and Sheard have shown, an increase in pigment content in the skin affects only one attribute of the color, namely, rela-

TABLE I.—SPECTRAL COLORS IN TERMS OF ELEMENTARY EXCITATIONS*

Wave length, millimicrons	Excitations			Wave length, millimicrons	Excitations		
	Red	Green	Violet		Red	Green	Violet
400			253	550	424	612	18
410			433	560	466	578	11
420			614	570	505	517	7
430			915	580	520	415	4
440		7	1,019	590	535	296	
450		16	950	600	510	196	
460		38	842	610	462	113	
470		81	842	620	375	59	
480	14	122	473	630	285	29	
490	41	169	220	640	195	10	
500	83	260	123	650	118	3	
510	151	391	87	660	68		
520	233	510	61	670	40		
530	307	572	43	680	22		
540	373	603	29	690 to 750	27		

*These values are for an equal energy spectrum. The relative magnitudes of the three elementary excitations have been chosen so that the curves for average noon sunlight have equal areas; that is, if the percentage values are plotted on a trilinear diagram, sunlight falls in the center. The absolute excitation values are based on a convenient arbitrary unit.

tive luminosity. The content of pigment of the skin and the relative luminosity bear a reciprocal relation to each other; when the pigment content is high, the relative luminosity is low and *vice versa*. The data of the red excitation values were used to determine the degree of erythema. One could just as well use the reciprocal of the violet excitation values. Or again, the purity data could be used, since the curves for the values of the red excitation and purity (Fig. 11) are almost identical. The red excitation values adapt themselves to the idea of erythema more logically than the other values.

RESULTS

The subject, M. H. R. (Table II), male, 25, of pronounced brunette type and considerably tanned on the exposed areas of the skin, although the skin protected by clothing was fair. The erythema, as evidenced by the red excitation values plotted in Figure 5, showed a wave which reached its highest value on the first day following irradiation and was completed on the third day. From then on there was a varia-

ble wave which reached its highest value on the sixteenth day, gradually decreasing until the twenty-first day, at which time there was a decided drop. Another wave started immediately, reaching its maximum on the twenty-sixth day. This point was the highest value of the erythema obtained in the entire course. From then until the forty-first day, there were rather marked undulations. On the forty-second day, the redness dropped to a level which existed before irradiation. Another wave rose to its peak on the forty-fifth day, dropping to its lowest point in that portion of the curve on the forty-ninth day. It was apparent also that another wave had formed and risen to a high level on the fifty-fifth day, when the experiment was ended. The relative luminosity or brilliance (Fig. 5) showed a fairly steady rate of decline to the forty-ninth day, followed by a rise to the fifty-fifth day. This corresponded to the evident increasing pigmentation which was present months after irradiation.

The subject, E. J. J. (Table III, Fig. 6), male, 36, of light brunette type. There was moderate tanning of the exposed por-

tions of the body. The erythema (red excitation values), which on the first day was less than that of the normal skin before irradiation, rose to a high value on the second day. Another wave of erythema

and day, with a sharp rise to the fifth day, and a more steady fall to the sixteenth day. The values then showed a more or less undulating course with some indication of waves between the sixteenth and thirtieth

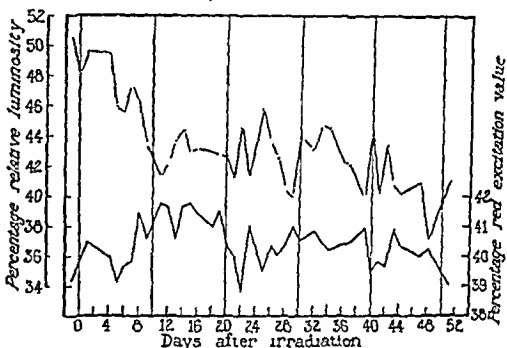
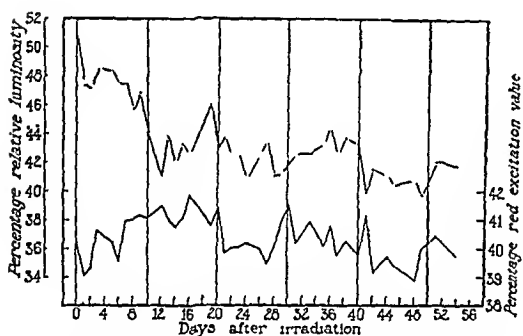
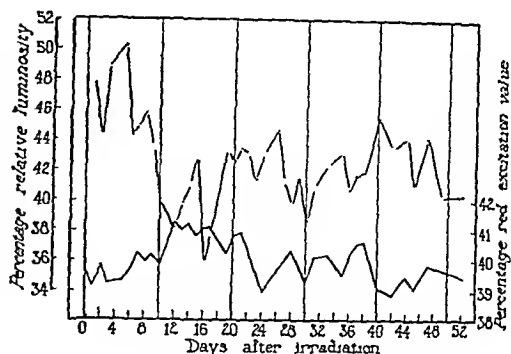
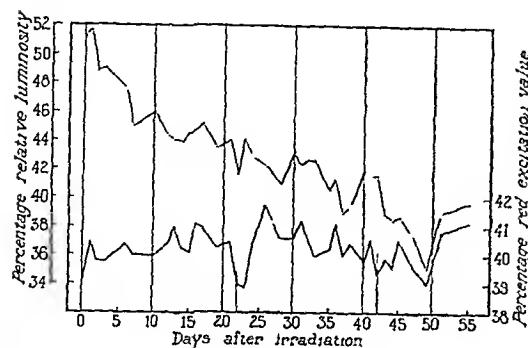


Fig. 5 (upper left). Subject M. H. R., curves of the relative luminosity (upper) and red excitation values (lower).

Fig. 6 (upper right). Subject E. J. J., curves of the relative luminosity (upper) and red excitation values (lower).

Fig. 7 (lower left). Subject D. G. V., curves of the relative luminosity (upper) and red excitation values (lower).

Fig. 8 (lower right). Subject H. R. C., curves of the relative luminosity (upper) and red excitation values (lower).

formed, reaching its highest value on the twelfth day, when it remained fairly constant until the twenty-first day. From there it dropped, to reach its lowest value on the twenty-fourth day. Three short waves followed, the highest point being on the thirty-eighth day, followed by a decrease in value to the forty-second day. Two other small waves were evident before the experiment ended. The relative luminosity (brilliance) values, as reciprocal evidence of tanning, showed a marked drop on the sec-

onds, and between the thirtieth and fiftieth days.

The subject, D. G. V. (Table IV, Fig. 7), was a woman, aged 25 years, a brunette, with moderate tanning of the exposed surface of the skin. The course of the erythema (red excitation values) decreased immediately after irradiation, being followed by a sharply rising wave which reached its crest on the third day and was completed on the sixth day. A well-formed wave, reaching its highest point on the six-

TABLE II.—SPECTROPHOTOMETRIC DATA FROM THE SUBJECT M. H. R.

Days after irradiation	Red excitation values	Green excitation values	Violet excitation values	Relative luminosity	Dominant wave length	Purity	Observed color of the skin*
	39.34	35.90	24.76	51.32	581	33	
1	40.43	35.72	23.85	51.82	584	36	R
2	39.81	35.69	24.50	48.86	583	33	R
3	39.77	35.84	24.39	49.09	582	34	
6	40.35	36.65	23.00	47.79	581	40	R T
7	40.00	35.92	24.08	44.99	583	35	R
10	39.98	36.83	23.19	46.02	580	38	R
12	40.39	36.73	22.92	44.29	580	40	
13	40.96	36.63	22.44	44.03	582	41	
14	40.25	37.20	22.54	43.94	579	41	R
15	40.09	36.57	23.34	44.50	580	38	
16	41.06	36.48	22.45	44.68	582	41	R
17	40.91	37.15	21.94	45.10	581	42	T
19	40.28	36.37	23.35	43.40	581	39	T
21	40.48	36.69	22.83	44.09	581	40	
22	38.95	36.09	24.95	41.54	585	32	T
23	38.86	36.49	24.65	44.19	579	33	T
24	40.12	36.36	23.52	42.91	580	35	T R
26	41.76	37.00	21.24	42.24	581	43	R
28	40.58	36.20	23.22	40.98	582	38	T
30	40.58	36.63	22.79	43.29	580	40	T
31	41.32	36.82	21.86	42.28	581	43	T
33	39.93	36.58	23.48	42.61	580	37	T
35	40.18	36.42	23.40	40.57	582	37	T
36	41.02	36.89	22.08	41.30	581	42	T R
37	40.03	36.15	23.82	38.89	581	36	T
38	40.43	36.00	23.57	39.40	583	37	T
40	39.75	37.00	23.25	41.94	580	38	T
41	40.53	35.32	23.15	41.51	582	39	T
42	39.32	36.84	23.83	41.58	579	36	T
43	39.90	35.92	24.18	38.87	582	35	T
44	39.55	35.29	25.16	38.46	584	31	T
45	40.56	36.75	22.69	38.78	583	40	T
47	39.61	35.09	25.30	37.49	585	30	T
49	39.04	35.05	25.90	34.91	584	28	T
51	40.78	36.33	22.89	38.98	582	40	T
55	41.14	36.84	22.01	39.70	581	42	R T

*R = redness; T = tanning

teenth day, followed the first wave. The low point of this wave occurred on the twenty-first day. A small wave developed, with its low point on the twenty-seventh day. This was followed by a sharp rise on the thirtieth day, an irregular curve with the low point on the forty-second day, and a still lower point on the forty-eighth day. There was evidence of a small wave preceding the end of the experiment on the forty-fourth day. The relative luminosity showed

a gradual decrease to the twelfth day, followed by a more or less level course with, however, a downward tendency. There were two waves present; one between the twelfth and twenty-fourth days and the other between the twenty-fourth and forty-ninth days.

The subject, H. R. C. (Table V, Fig. 8), was a woman, aged 25 years, definitely a blonde; there was little tanning of the exposed areas of skin. The first reading was

TABLE III.—SPECTROPHOTOMETRIC DATA FROM THE SUBJECT E. J. J.

Days after irradiation	Red excitation values	Green excitation values	Violet excitation values	Relative luminosity	Dominant wave length	Purity	Observed color of the skin
	39.60	36.20	24.20	47.77	581	33	
1	39.10	36.20	24.70	47.62	581	32	
2	39.80	35.85	24.34	44.08	583	35	
3	39.20	36.37	24.43	48.83	580	33	
5	39.30	36.26	24.44	50.26	581	32	
6	39.69	36.70	23.61	44.28	580	36	R ?
7	40.26	36.52	23.21	44.85	581	38	
8	39.94	35.80	24.26	45.83	582	34	
9	40.17	36.17	23.65	43.39	582	37	
10	39.80	36.30	23.91	39.95	580	36	
12	41.23	36.71	22.06	38.16	582	42	
13	40.94	35.90	23.16	39.70	584	38	
14	41.18	36.97	21.85	40.66	580	42	
15	40.78	36.84	22.38	42.86	580	41	
16	41.00	35.67	23.33	35.75	584	38	R ?
17	41.09	36.20	22.70	39.83	583	40	T
19	40.17	36.80	23.03	43.33	581	39	
20	40.77	37.48	21.74	42.42	580	42	T
21	40.89	36.98	22.13	43.43	581	42	
22	40.31	36.51	23.14	43.07	581	38	T
23	39.58	35.86	24.56	41.12	581	34	T
24	38.93	35.66	25.41	42.96	582	30	
26	39.62	36.90	23.48	44.83	580	36	R
27	39.93	36.45	23.62	41.10	581	37	
28	40.25	36.20	23.55	39.44	582	37	
29	39.77	36.70	23.53	41.89	580	37	T
30	39.22	35.59	25.19	38.25	584	31	
31	40.09	36.06	23.85	40.81	582	36	R T
33	40.13	36.35	23.52	42.32	582	37	R T
35	39.44	36.05	24.51	43.12	581	34	R ?
36	40.16	36.16	23.68	40.59	583	36	T
37	40.46	36.05	23.49	41.82	583	37	
38	40.57	37.15	22.28	41.63	579	42	
40	39.02	36.92	24.06	45.75	579	35	R
42	38.80	35.91	25.30	43.43	585	31	T ?
44	39.42	36.23	24.35	44.17	581	34	T
45	39.08	36.28	24.64	40.73	580	33	T
47	39.84	37.00	23.15	44.24	579	38	
49	39.63	36.09	24.28	40.15	582	34	T
52	39.42	35.71	24.87	40.28	581	32	T

made three hours after irradiation. Visible redness was present. The red excitation values showed the beginning of a wave of erythema which reached its highest value on the day following irradiation, being completed on the fifth day. A sharply outlined wave of erythema, with a somewhat irregular crest, followed. The highest point occurred on the fifteenth day. The lowest point of this second curve occurred on the twenty-second day. This was followed im-

mediately by an irregular third wave, with high points on the twenty-third, twenty-ninth, and thirty-ninth days. The low point occurred on the fortieth day, followed by a wave lasting eleven days, with the lowest point on the fifty-first day. This third wave apparently extended from the twenty-second day to the fifty-first day.

The relative luminosity values (brilliance) showed a steady decline until the eleventh day, followed by an irregular course with a

TABLE IV.—SPECTROPHOTOMETRIC DATA FROM THE SUBJECT D. G. V.

Days after irradiation	Red excitation values	Green excitation values	Violet excitation values	Relative luminosity	Dominant wave length	Purity	Observed color of the skin
	40.20	36.09	23.71	50.43	581	35	
1	39.02	35.82	25.16	47.56	581	32	R
2	39.35	35.58	25.07	47.14	582	32	R
3	40.64	36.23	23.13	48.58	582	37	R
5	40.22	36.00	23.78	48.33	583	35	R
6	39.58	35.92	24.50	47.42	583	33	R
7	40.97	36.20	22.83	47.47	582	38	
8	41.20	36.14	22.66	45.61	583	40	
9	41.12	36.10	22.78	46.97	584	39	R
10	41.06	36.73	22.21	44.16	581	42	R
12	41.50	36.33	22.17	40.93	583	41	R
13	41.06	36.36	22.58	43.96	582	40	R
14	40.79	35.98	23.23	41.89	584	38	R
15	41.08	36.24	22.68	43.39	583	40	R T?
16	41.83	36.23	21.94	42.47	584	42	R
19	40.79	36.37	22.84	46.15	582	40	R
20	41.36	36.93	21.71	42.91	580	42	
21	39.83	35.98	24.18	43.97	582	34	
22	40.03	36.39	23.58	42.36	580	37	T
23	40.03	36.11	23.86	42.43	583	36	T
24	40.17	36.07	23.76	40.81	582	35	R
26	39.96	36.06	23.98	42.44	583	35	R
27	39.42	35.65	24.93	45.49	582	32	R
28	40.03	36.37	23.59	41.04	581	36	R
29	40.98	36.40	22.62	41.23	583	41	T R
30	41.52	36.21	22.27	38.46	583	42	T
31	40.14	36.25	23.61	42.60	581	37	R T
33	40.94	36.84	22.22	42.65	581	42	T R
35	40.06	35.59	24.35	43.24	584	34	T R
36	40.78	36.90	22.32	44.43	580	41	R T
37	39.71	36.64	23.64	42.53	580	36	R T
38	40.34	36.85	22.81	43.68	580	40	R T
40	39.77	36.00	24.23	43.34	582	34	T R
41	41.14	35.83	23.03	39.79	584	38	T R
42	39.14	35.74	25.12	41.66	582	32	T
44	39.73	35.64	24.63	41.08	583	33	T
45	39.46	36.47	24.07	40.45	580	35	R T
48	38.85	35.32	25.82	40.80	580	30	T R
49	39.94	35.66	24.40	39.65	584	34	T R
51	40.46	36.34	23.20	42.08	581	38	T R
54	39.72	35.73	24.55	41.71	583	33	

downward tendency. Two fairly definite waves could be made out, which occurred between the eleventh and twenty-first days and between the twenty-ninth and thirty-ninth days.

The subject, F. H. D. (Table VI, Fig. 9), male, 30, of brunette type, with unexposed portions of skin somewhat darker than that of the other subjects. The first wave of erythema had a crest on the second day and

its low point on the fifth day following irradiation. The second wave was very irregular, having crests on the seventh, ninth, thirteenth, and nineteenth days. The lowest point of this wave was on the twenty-second day. The third wave, which was also very irregular, reached its crest on the thirty-sixth day. Its lowest point was on the forty-seventh day, followed by a rising erythema to the fifty-second day, at which

TABLE V.—SPECTROPHOTOMETRIC DATA FROM SUBJECT H. R. C.

Days after irradiation	Red excitation values	Green excitation values	Violet excitation values	Relative luminosity	Dominant wave length	Purity	Observed color of the skin
0	39.18	36.11	24.71	50.48	581	32	
0	39.93	36.17	23.90	48.02	580	36	R
1	40.47	35.92	23.60	49.61	582	36	R
4	39.98	35.99	24.03	49.59	583	35	
5	39.10	35.68	25.22	45.90	581	31	R
6	39.62	35.91	24.46	45.47	581	33	R T?
7	39.75	35.83	24.42	47.55	582	34	R
8	41.38	36.36	22.26	46.29	582	41	R
9	40.51	36.29	23.20	43.65	582	39	
11	41.79	36.04	22.17	41.26	584	41	R
12	41.60	36.56	21.84	42.20	582	42	T R?
13	40.52	36.27	23.21	43.70	582	38	
14	41.63	36.91	21.46	44.51	582	43	R
15	41.78	36.76	21.46	42.97	582	44	R
16	41.45	36.64	21.90	43.14	582	42	T
18	40.94	36.93	22.13	42.95	580	42	R T
19	41.51	36.98	21.51	42.78	581	43	
20	40.30	36.64	23.06	42.78	580	39	R
21	40.02	36.50	23.48	41.16	580	37	
22	38.79	36.52	24.69	45.00	579	34	T R?
23	41.00	37.21	21.78	41.13	580	43	T R?
25	39.48	36.55	23.97	45.81	580	35	R
26	40.35	36.38	23.27	43.48	581	38	R T?
27	40.02	36.28	23.70	42.51	581	36	R T
28	40.40	36.35	23.25	40.43	581	37	R T
29	40.97	36.36	22.67	39.95	582	40	T R
30	40.50	36.93	22.57	43.97	580	41	R T
32	40.86	37.21	21.93	43.12	580	42	T
33	40.47	36.41	23.12	44.71	582	37	R T
34	40.20	35.96	23.84	44.60	582	36	R
36	40.38	36.23	23.39	42.21	581	38	
37	40.42	36.74	22.84	42.06	580	40	R
39	40.89	36.60	22.51	39.82	581	41	T
40	39.42	36.05	24.53	44.20	581	33	T
41	39.81	36.19	24.00	40.07	581	35	T
42	39.62	35.50	24.88	43.20	580	32	R T
43	40.79	36.60	22.61	40.74	581	40	T
44	40.34	35.95	23.71	40.18	582	35	
47	39.96	36.08	23.96	40.95	582	35	
48	40.21	34.85	24.94	36.87	585	32	T R?
51	38.98	35.71	25.31	40.87	583	31	R

time the experiment ceased. The relative luminosity values showed a slightly irregular fall to the thirteenth day, followed by an irregular course with a tendency upward. No wave forms were apparent.

The subject, S. A. M. (Table VII, Fig. 10), male, aged 30, of marked brunette type, with considerable tanning of the exposed areas of skin. The erythema showed the first crest of a wave on the sixth

day and its low point on the eighth day. Then followed a wave with its crest on the tenth day and its minimal value on the sixteenth day, followed by another wave with its crest on the twentieth day and its low point on the twenty-first day. The second wave apparently included the last two waves and extended from the eighth to the twenty-first days. Between the twenty-first and the forty-second days the usual third wave

TABLE VI.—SPECTROPHOTOMETRIC DATA FROM SUBJECT F. H. D.

Days after irradiation	Red excitation values	Green excitation values	Violet excitation values	Relative luminosity	Dominant wave length	Purity	Observed color of the skin
0	38.51	36.00	25.49	48.30	585	30	
1	38.94	36.12	24.93	49.02	580	32	
2	39.56	36.14	24.30	48.53	580	34	
3	39.31	36.06	24.63	43.32	582	33	T
5	38.86	35.68	25.54	45.26	583	30	T
6	38.96	36.19	24.85	46.09	580	32	
7	40.27	36.51	23.22	45.72	581	39	
8	39.10	35.77	25.12	44.80	583	31	R
9	40.60	36.27	23.13	45.03	583	37	T R
10	38.53	36.70	24.77	48.14	579	33	
12	40.19	36.61	23.20	46.22	581	38	R?
13	40.75	35.18	24.07	41.14	585	35	
14	40.74	36.78	22.48	43.86	582	40	T?
15	39.90	36.89	23.21	47.09	580	38	R
16	39.32	35.68	25.00	45.41	583	32	R
17	39.73	35.02	25.24	43.66	585	30	
19	40.69	36.41	22.86	40.96	581	40	R
20	40.04	36.24	23.72	45.04	581	37	R
21	39.17	36.14	24.69	42.97	580	32	
22	38.70	36.03	25.27	42.61	580	30	R
26	39.73	36.27	24.00	45.90	580	35	R
27	39.32	36.01	24.67	45.47	581	32	R
28	39.53	36.18	24.29	44.19	580	34	T
29	40.06	36.67	23.27	43.93	580	38	T R
30	39.01	36.47	24.52	44.69	580	34	T R
31	39.45	36.13	24.42	45.05	580	33	
33	39.53	36.29	24.18	47.33	581	35	T
35	40.25	36.82	22.93	49.33	580	38	
36	40.30	36.41	23.29	45.99	580	38	T
37	38.71	36.25	25.04	49.09	580	32	T
38	39.15	36.62	24.23	46.10	580	34	T
40	39.47	35.88	24.65	49.85	581	33	T
41	38.87	36.26	24.87	51.24	580	33	
42	38.33	36.16	25.51	46.14	580	30	T
43	38.66	35.37	25.97	43.66	582	28	T
44	39.46	35.61	24.93	46.25	583	32	
47	38.27	35.91	25.82	44.29	580	29	T
49	38.44	35.74	25.82	49.62	581	29	
52	40.03	36.47	23.50	45.76	580	37	T

occurred, made up of three smaller waves. The crests of these three waves were on the twenty-eighth, thirty-fifth, and forty-first days, respectively. After the forty-second day, an irregular wave with low maximal values was evident, showing a rise to the fifty-fourth day, at which time the readings ended. The relative luminosity showed a decrease to the tenth day, followed by an irregular course with a tendency downward. Three wave forms were more or less evident: the first between the tenth and twen-

tieth days; the second between the twentieth and twenty-ninth days, and the third between the twenty-ninth and forty-fifth days.

The green excitation values of all these subjects (Tables II to VII) remained practically at a constant level. There was only a slight increase when the red excitation values were highest. The violet excitation values showed an almost exact inverse relationship to the red excitation values. The purity (percentage value of saturation) showed the same variations as the red exci-

TABLE VII.—SPECTROPHOTOMETRIC DATA FROM SUBJECT S. A. M.

Days after irradiation	Red excitation values	Green excitation values	Violet excitation values	Relative luminosity	Dominant wave length	Purity	Observed color of the skin
0	38.69	35.66	25.65	48.40	583	27	
1	39.12	35.78	25.19	49.89	583	30	
2	39.35	35.87	24.78	43.52	582	32	
3	39.80	35.85	24.35	44.07	583	34	
5	39.94	35.44	24.62	46.29	585	32	R
6	40.17	36.71	23.12	45.72	582	39	T
7	39.97	36.03	24.00	41.84	583	35	
8	39.81	36.29	23.90	44.26	582	35	
9	40.23	35.38	24.39	42.26	584	34	R
10	41.04	36.50	22.46	39.63	582	40	
12	40.68	36.52	22.80	43.81	582	40	
13	40.14	36.45	23.41	45.08	581	38	R
14	39.76	36.57	23.67	41.63	580	36	
15	39.44	36.27	24.29	43.19	581	34	R
16	39.46	36.50	24.04	41.79	580	35	T R
17	40.16	35.77	24.07	42.06	583	35	
19	41.06	36.30	22.64	39.87	583	40	R
20	41.07	36.67	22.26	38.91	581	41	T
21	39.04	35.33	25.63	40.25	584	30	
22	39.95	36.00	24.05	41.51	582	35	T
23	40.15	35.54	24.31	40.10	584	34	T
24	40.16	36.35	23.49	42.23	581	37	R T
26	40.24	36.44	23.32	42.17	581	38	R
27	40.51	36.64	22.85	43.13	581	39	T
28	41.15	36.43	22.42	38.97	582	40	R T
29	39.34	36.22	24.44	40.05	581	32	T
31	40.26	36.35	23.39	41.24	581	38	
33	40.40	36.59	23.01	41.67	581	39	T
35	41.05	36.50	22.45	40.11	582	39	R
36	39.78	36.01	24.21	42.30	582	35	R T
37	39.32	36.83	23.85	42.85	580	37	T
38	39.28	35.95	24.77	40.39	582	33	T
40	39.78	35.74	24.48	41.53	582	34	T
41	40.52	35.42	24.06	38.77	585	35	T R
42	39.06	36.36	24.50	41.95	580	34	T
43	39.40	35.35	25.25	40.17	585	31	T
44	39.05	36.29	24.66	42.56	580	32	T
45	39.42	35.61	24.97	36.38	582	32	T
49	39.82	35.85	23.33	39.32	581	34	T
51	39.27	35.88	24.85	39.60	581	32	T
54	40.03	35.04	24.93	37.82	585	31	T

tation values. The dominant wave length (hue) varied between 579 and 585 millimicrons. Most of the determinations were between 581 and 583 millimicrons. The slight variations bore no relationship to the variations in the other values.

Direct visual observation of the color of the skin was made with no intent other than to determine, if possible, when the erythema and tanning were present. No attempt was

made to record accurately any quantitative results. The recorded visual results corresponded only roughly to the spectrophotometric data of the erythema or redness of the skin, corresponding more accurately, however, to the tanning of the skin. That is, when the relative luminosity was low, the skin appeared to be tanned.

The composite of the data presented in the preceding tables and figures is given in

TABLE VIII.—MEANS OF THE SPECTROPHOTOMETRIC DATA CONTAINED IN

TABLES II, III, IV, V, VI, AND VII

Days after irradiation	Number of subjects in mean	Red excitation values	Green excitation values	Violet excitation values	Relative luminosity	Dominant wave length	Purity
0	6	39.37	36.00	24.61	49.04	581.8	32.3
1	6	39.51	35.92	24.57	49.25	581.8	33.0
2	5	39.57	35.82	24.59	46.42	582.0	33.2
3	5	39.74	36.07	24.18	46.77	581.8	34.2
5	5	39.48	35.81	24.72	45.40	582.6	32.0
6	6	39.72	36.34	23.92	46.12	581.1	35.5
7	6	40.20	36.16	23.62	45.40	582.0	36.5
8	5	40.25	36.07	23.64	45.35	582.4	36.2
9	5	40.52	36.04	23.43	44.26	583.0	37.2
10	5	40.08	36.61	23.30	43.58	580.4	37.8
12	6	40.93	36.57	22.49	42.60	581.6	40.5
13	6	40.72	36.13	23.17	42.93	582.6	38.3
14	6	40.72	36.73	22.54	42.74	581.1	40.0
15	6	40.51	36.59	22.89	44.00	581.0	39.1
16	6	40.68	36.20	23.09	42.20	582.5	38.3
17	4	40.47	36.03	23.48	42.66	583.0	36.7
19	6	40.75	36.53	22.70	42.74	581.5	40.1
20	5	40.70	36.79	22.49	42.41	580.4	40.2
21	6	40.64	36.27	23.82	42.64	581.3	35.8
22	6	39.45	36.25	24.28	42.68	581.1	34.3
23	5	39.92	36.24	23.63	41.79	581.4	36.0
24	4	39.84	36.11	24.04	42.22	581.2	34.2
26	6	40.27	36.50	23.21	43.51	581.0	37.5
27	5	39.84	36.20	23.95	43.54	581.2	35.2
28	6	40.32	36.28	23.38	40.84	581.3	37.0
29	5	40.13	36.47	23.30	41.41	581.2	37.6
30	5	40.16	36.36	23.46	41.73	581.4	37.6
31	5	40.25	36.32	23.42	42.39	581.0	37.4
33	6	40.23	36.51	23.25	43.54	581.6	37.8
35	5	40.19	36.27	23.52	43.27	581.0	36.4
36	6	40.40	36.17	23.16	42.80	581.1	36.3
37	6	39.78	36.44	23.78	42.87	580.6	36.3
38	5	39.95	36.51	23.53	42.24	580.8	37.2
40	6	39.53	36.26	24.19	44.43	580.8	34.5
41	5	40.17	36.00	23.82	40.27	582.4	36.0
42	6	39.04	36.08	24.85	42.99	581.0	32.5
43	4	39.68	35.81	24.50	40.86	582.5	33.5
44	6	39.59	35.83	24.40	42.11	582.1	32.8
45	4	39.63	36.27	24.09	39.02	581.2	35.0
47	4	39.42	36.02	24.55	41.74	581.5	33.0
49	5	39.37	35.67	24.94	40.73	582.4	31.8
51	4	39.87	36.08	24.06	40.38	581.7	35.2

Table VIII and Figure 11, representing the average values of six cases only. It is to be interpreted in this light. The relative luminosity decreased steadily to about the fortieth day, followed by a slightly less rapid decrease to the fifty-first day. The red excitation values showed a wave having

its crest on the third day and its low point on the fifth day. This was followed by a second wave, reaching its highest value on the twelfth day. Its course was fairly level until the twenty-first day, from which point it dropped to a low level on the twenty-second day. A third wave began imme-

diately thereafter, occurring between the twenty-second and forty-second days. There was little evidence of activity after the forty-second day, as shown by the curve of percentage red excitation (Fig. 11). The

currence in the six cases studied are shown in Table IX.

The first wave of erythema reached its highest value in an average of 2.5 days, with its succeeding low value at six days,

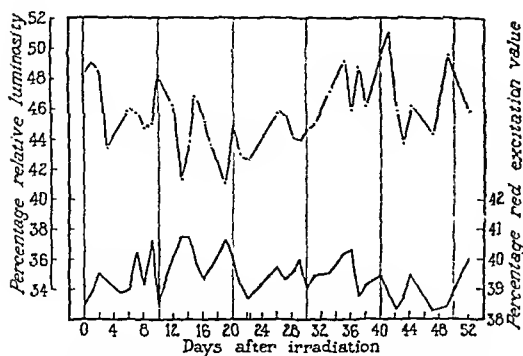


Fig. 9. Subject F. H. D., curves of the relative luminosity (upper) and red excitation values (lower).

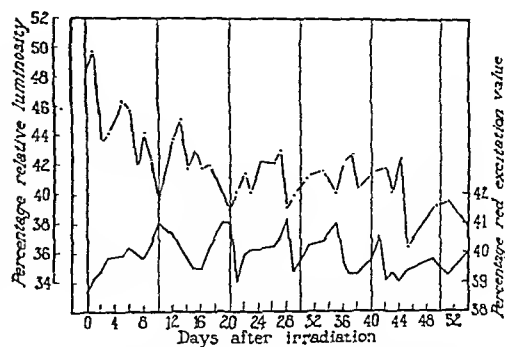


Fig. 10. Subject S. A. M., curves of the relative luminosity (upper) and red excitation values (lower).

third wave was evidently lower in intensity than the second. The green excitation values maintained an almost level course. There was, however, a slight increase in this value when the red excitation values were the highest. The violet excitation values evidenced a reciprocal relationship to the red excitation values. The purity (percentage saturation) values showed, in a more pronounced fashion, the same variations as the red excitation values. The dominant wave length (hue) varied between 580.4 and 583 millimicrons, the course tending to remain constant.

COMMENT

In general, the course of the values of color excitation was cyclic. The rhythm was similar in certain particulars in the different subjects. Definite cycles of erythema and, at times, of tanning were present, as well as rather definitely timed maximums and minimums in the course of the erythema of all the subjects. The average high and low points and the average chronologic oc-

currence in the six cases studied are shown in Table IX.

The first wave of erythema reached its highest value in an average of 2.5 days, with its succeeding low value at six days, on the average. This corresponded exactly to Miescher's first wave, for Miescher found that the maximal point of the first wave occurred, on the average, in two days.

The second wave reached its highest value between the thirteenth and the twentieth days, with an average of 15.6 days. Its low value occurred between the twenty-first and twenty-fourth days, or, on an average, in 22.1 days. This corresponded definitely to Miescher's second wave.

The third wave reached its maximal value between the twenty-eighth and thirty-eighth days, or, on the average, in thirty-two days. Its minimal value occurred between forty-two and fifty-one days, or in 46.5 days, on the average. Therefore, the third wave, as we determined it, extended from the twenty-second day to the forty-sixth day. Miescher described the third wave as occurring between the thirty-fourth and fifty-first days, stating also that this third wave was the most intense of the rhythmic course. In our investigations, the third wave, with one exception (subject N. H. R.), was less pro-

TABLE IX.—AVERAGE HIGH AND LOW POINTS OF THE DIFFERENT WAVES AND MEAN TIME RELATIONS

Subject	First wave				Second wave				Third wave			
	High	Day	Low	Day	High	Day	Low	Day	High	Day	Low	Day
M. H. R.	40.43	1	39.77	3	41.06	16	38.86	23	41.32	31	39.04	49
E. J. J.	39.80	2	39.20	3	41.18	14	38.93	24	40.57	38	38.80	42
D. G. V.	40.64	3	39.58	6	41.83	16	39.83	21	41.52	30	38.85	48
H. R. C.	40.47	1	39.10	5	41.78	15	38.79	22	40.97	29	38.98	51
F. H. D.	39.56	2	38.86	5	40.75	13	38.70	22	40.30	36	38.27	47
S. A. M.	40.17	6	39.81	8	41.07	20	39.04	21	41.15	28	39.06	42
Means:	40.17	2.5	39.38	6.0	41.32	15.6	39.02	22.1	40.97	32.0	38.86	46.5

nounced than the second wave, as is evident from the mean values given in Figure 11. There was also evidence, both from visual and spectrophotometric observations, that the erythemic reaction continued after the occurrence of the third wave.

The apparent, but unimportant, variation in the time of occurrence and duration of the third wave in our investigations and of Miescher's results may be due to the fact that pigment obscures the erythema in visual observation so that accurate readings are impossible. In the spectrophotometric determinations, however, pigmentation affects only the relative luminosity, not the chromic values.

There were, however, considerable differences in the courses of the erythema produced in the various persons examined by us. The greatest differences are exhibited by the subjects S. A. M. and F. H. D., for the rhythm in these cases is very dissimilar from the others. This supports the contention of Leddy and Weatherwax, and others, that marked individual variations follow the administration of a uniform dose of roentgen rays.

The values of the relative luminosity (brilliance) were taken as indicators of the content of pigment in the skin. In general, the courses of these values showed rhythm. After the preliminary decrease and immediate increase in the values of the relative

luminosity occurring during the first few days, there was a gradual decrease at a rate which was fairly constant until a time varying between the eleventh day and the fifteenth day was reached; hence the content of pigment underwent rapid variations during the few days immediately after irradiation. Subsequent to these initial variations, there was an increase in the content of pigment, which progressed at a fairly steady rate for from eleven to fifteen days. After this period, the content of pigment in one case (subject F. H. D.) decreased; it remained at about the same level with cyclic variations in three cases (subjects E. J. J., D. G. V., and H. R. C.), and decreased at a more or less constant rate in two cases (subjects M. H. R. and S. A. M.). There were, therefore, marked variations in the course and amount of pigmentation in the skins of subjects after roentgen irradiation. However, it was quite evident that the pigmentary changes, or the changes in the processes involved in the development of pigment, were independent of the erythemic changes in the skin.

The hue (dominant wave length) remained practically constant, ranging from 579 to 585 millimicrons. The purity (saturation) followed the course of the erythema as indicated by the spectrophotometric determinations of the values of red excitation. These experimental observations rela-

tive to hue, color excitation, and saturation indicate that the quality of the blood remains constant, whereas the increase in redness (erythema) is due chiefly, if not wholly, to an increase in the quantity of

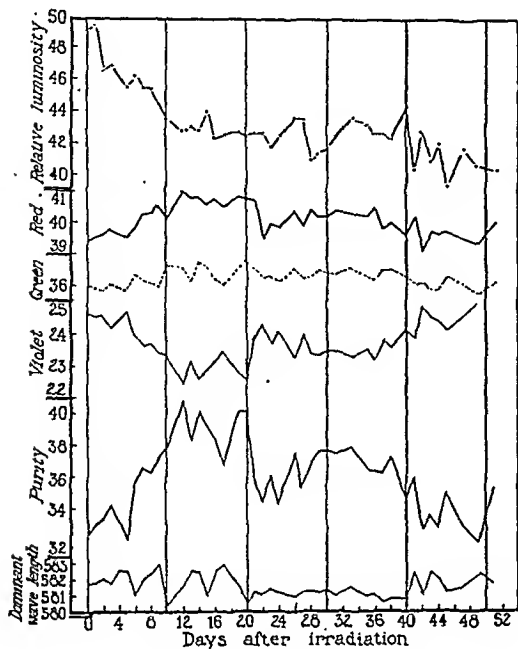


Fig. 11. Curves showing the average values of the relative luminosity, color excitation (red, green, and violet), purity, and dominant wave length.

blood in the peripheral vessels. As Brunsting and Sheard showed, any change in the quality of the blood dependent on the content of oxygen causes a shift in hue toward the red end of the spectrum in hyperemia and toward the blue end of the spectrum in congestion. Hence it may be concluded that the increased redness (erythema) following irradiation is due to the more complete opening of the capillaries and to a great number of open capillaries in the skin, thereby allowing a greater quantity of normal blood to be present. This conclusion is supported by the investigations of the others who have studied the capillaries of the skin.

Although we know little regarding the nature of the physical and chemical factors

which produce the changes in function of the capillaries and the pigmentary processes, we may conclude that the same physical agent, that is, roentgen rays, causes both of them. It is certain that the erythema of the skin followed a rhythmic course after roentgen irradiation. Hence it is not logical to assume that the changes in the function of the capillaries are due to a single dose of roentgen rays acting for a short time, the effect of which deteriorates at a fairly constant rate. If such were the case, the relationship between erythema and the time in days after the application of a single dose of roentgen rays would be a straight line on semilogarithmic paper. The values of the relative luminosity, when plotted semilogarithmically, show some semblance to straight lines over a period of from eleven to fifteen days, after which marked irregularity exists. There are rapid variations in pigmentary values, thus indicating that pigment is markedly labile.

It is still a moot question if the erythema produced by irradiation is a measure of the biologic effects produced in the tissues by such irradiation. If it can be assumed that erythema is a biologic change resulting from roentgen rays, and if the mechanism of effect in deep tissues differs in no fundamental respect from that in the skin, then it is logical to assume that reactions in the deeper tissues will closely parallel those observed in the skin. Miescher, Reisner and Neeff, and others, have shown by clinical observation that rhythmic variations in erythema occur and that these variations persist for a considerable period. From an accurate analysis of data regarding hue, saturation, and relative luminosity obtained spectrophotometrically, we have shown that the course of the erythema is cyclic. The course of development of pigment is apparently independent of, and dissimilar to, the course of the erythema, although rhythm, or decided maximums and minimums, ap-

pears after about the fifteenth day following irradiation. In some recent investigations by Williams and Sheard regarding the electric differences of potential across frog's skin and the ratio of consumption of oxygen, it is shown that there is rhythm, or cyclic variation, in both electric potentials and consumption of oxygen. Again, therefore, it would seem that a rhythmic, or wave, type of relationship between the physiologic effect of roentgen rays and the time after irradiation expresses the correct time-effect relationship. The periods of increased potential and consumption of oxygen may be considered as periods of increased activity or vitality, whereas the periods of decreased potential and consumption of oxygen may be presumed to indicate lowered vitality, or periods of injury. The fact that the effects of irradiation on the potential differences and rates of consumption of oxygen appear as rhythmic types of reaction may be due in part to the action of the normal metabolic processes of the cells to counteract, or repair, the injury which has been suffered. Oxidative processes which are proceeding at an abnormal rate may instigate reactions which tend to counteract or interrupt the rate of oxidation. After this has been accomplished, the inhibitory agent may cease to exert its influence and the tendency toward an abnormal rate again may make itself evident. So far as we know, there has been no correlation between these cyclic effects on the electric potentials and rates of consumption of oxygen of irradiated skin on the one hand and the cyclic effects on cutaneous erythema and the less marked rhythm in the development of pigment on the other. We are able only to state: (1) There is a fairly constant rate of development of pigment for a period of from eleven to fifteen days after roentgen irradiation, followed by marked irregularity with subsequent evidences of rhythm, and (2) there is a rhythm or cyclic course of

erythema, as evidenced by the curves of percentage red excitation, which is associated largely if not wholly with the amount and distribution of blood in the capillaries of the skin.

CONCLUSIONS

1. Spectrophotometry offers an accurate method of recording the changes of color in the skin following irradiation.
2. The course of the erythema is cyclic, or wave-like, persisting over a period of months.
3. Fairly definite points occur chronologically at which the erythema is at a minimum.
4. Changes in the content of pigment of the skin are due to a primary effect of the rays on the pigment, or on the metabolic processes by which pigment is formed.
5. The content of pigment is immediately affected by irradiation.
6. The pigment follows a course independent of the course of the erythema.
7. The hue of the skin following irradiation remains constant.
8. The changes in redness of the skin following roentgen irradiation are due to changes in the saturation of the hue.

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Goldfish under X-ray Show Development of Pigment.—Forty-seven goldfish have been given X-ray tests to shed light on the little-understood subject of the cause of the formation of pigment-carrying cells in man and lower animals. In man, these pigment-carrying cells erupt in the skin, forming unsightly dark blue patches. Sometimes these patches are birthmarks, sometimes acquired later, as the result of injuries or irritations.

Results of the goldfish experiments are reported to the *American Journal of Cancer* by Dr. George Milton Smith, of the Yale University School of Medicine.

In order to X-ray only one side of forty-seven lively fish, Dr. Smith anesthetized his small subjects. After five or six days of carefully regulated X-ray treatment, the exposed side of each fish began to erupt tiny cells carrying dark coloring matter. These

made splotches of black under the transparent outer skin of the fish, and formed interlacing patches against the dark red bodies of the fish. After the treatments, the dark patches remained for almost two weeks and then took from eleven days to about a month to disappear, leaving the fish in the same state as before the experiment—except for four subjects that were so acutely affected that they died, apparently from a secondary infection.

Why X-ray exposure causes goldfish to respond by mobilizing these dark, color-carrying cells in the skin is not yet clear, Dr. Smith reports. There is, he suggests, some connection with repair and defense processes. The whole matter is important to physicians because of the possible connection of the formation of these pigment cells, or melanophores, with the development of pigmented tumors.—*Science Service*.

MEDICO-LEGAL DEPARTMENT

THE PRÆCIPE

By I. S. TROSTLER, M.D., F.A.C.R., F.A.C.P., CHICAGO

The præcipe is an archaic and antiquated legal document, the use of which is still current in about half of the States of this country, while in the others it has fortunately passed into obsolescence and disuse.

This document, where still in use, permits the institution or commencing of a lawsuit *without any explanation or elucidation of the cause of the action*. The most reputable citizens of high standing may be named as defendants in these cases and thereby be subjected to all sorts of inference or conjecture. The suit may not be and *often is not* pressed or followed up, and still the defendant has no redress or remedy at law.

The præcipe itself is a simple document, containing the mere statement that John Doe is suing Joseph Roe for a certain sum of money and naming John Doe's attorney. No hint of the cause of the action is necessarily included, and under the law in the States where it is still permitted, the plaintiff is not required to substantiate the righteousness or justice of his claim until he is ready to file a declaration or withdraw the præcipe.

It is during this period—after the filing of the præcipe and before a declaration is filed—that unscrupulous lawyers press claims and arguments for settlement, and intimidate defendants into paying for a withdrawal or settlement, for fear of publicity and scandal.

Originally, the præcipe was a mandatory letter from the King of England, written by his Chamberlain and bearing his Great Seal. It was directed to the sheriff of the county wherein an alleged injury was committed, and required that the sheriff command the

accused party to render justice to the complainant or answer to the accusation against him in court. A legal maxim of the time was that no proceedings could be tried before the King's judges without his (the King's) original writ or præcipe. It was deemed unfit that these judges—being substitutes for the King—should take cognizance of anything except such as had been called to their attention by His Majesty. In those early times, when a complaining witness or plaintiff failed to prosecute a suit after filing a præcipe, he was liable to a fine or imprisonment or both, but in these modern and more intellectually advanced times of ours, there is no penalty imposed for this action in such States as still permit the filing of this opprobrious document, which nearly all honorable attorneys decline to use, and which is used only by attorneys of low ethical and moral standards—legal quacks or legal charlatans.

The writer has personal knowledge of numerous instances wherein præcipes were filed, stating that suits were to be brought for large sums of money, but which were withdrawn after more or less extended periods, either with or without the payment of various sums of money.

This is a favorite document and method of legal procedure for attorneys alleging breach of promise, alienation of affection, medical malpractice and other similar actions smacking of blackmail or extortion, particularly in the more densely populated centers. It is still in use in Illinois.

Physicians when served with this document need have little fear, as a general thing, as in nearly every instance it will prove to be *vox et præterea nihil*.

CASES CITED¹

UNSUCCESSFUL TREATMENT OF TIBIAL FRACTURE WITHOUT ROENTGENOGRAM

De Bruine *vs.* Voskuil *et al.* (Wis.), 169 N.W.R. 288

The Supreme Court of Wisconsin not only reverses a judgment for \$1,800 damages obtained by the plaintiff for injuries alleged to have been sustained by reason of negligence on the part of the defendants in the treatment of a fracture of the tibia of the plaintiff's left leg about two inches below the knee, but remands the case with directions to dismiss the plaintiff's complaint on the merits. The Court says that the plaintiff was a woman 49 years old. The accident occurred November 5. The defendants reduced the fracture and placed it in a fracture box in the ordinary way with Buck's extension, attaching a weight of 26 pounds. December 20, defendant Voskuil removed the apparatus, a part of the weight having been taken off a week previously; and he attempted to ascertain whether or not union had taken place, but desisted on account of complaints made by the plaintiff. He advised her to use her leg. He called again, December 27, and then discovered that there was no union of the fragments. He then advised an operation for the purpose of fastening the ends of the bones together. The plaintiff was taken to a hospital in Sheboygan, where another surgeon performed an operation, ten weeks after which the plaintiff returned to her home, with the bone united perfectly, but her left ankle stiff. It was undisputed that prior to the operation there was never any exudate on the ends of the bones.

There was no evidence to show that the bones were not properly placed in apposition to each other, and there was no evi-

dence to show that the weights were not properly attached in the usual and customary way. If an expert could not say that the treatment was improper, on what ground could the jury arrive at that conclusion? The fact being established that there was no union, it was assumed apparently that it must be due to some negligent treatment. The evidence did not sustain that view. The entire case here rested on the testimony of a physician to the effect that he would have treated the fracture in another way. Physicians are not compelled to choose at their peril between two accepted methods of treatment. Statements of experts that they would have treated the fracture in some other way are incompetent.

The trial court correctly instructed the jury that:

"A physician and surgeon is not an insurer or guarantor of a cure. If the treatment in this case was such as physicians or surgeons of ordinary knowledge and skill of the same school of medicine, and practising in the same vicinity, would have exercised under the same or similar circumstances, then the fact that a bad result followed from the treatment, if you find that that was the fact, is not in itself alone sufficient to charge the defendants or either of them with negligence."

The difficulty seemed to be that the trial court entirely ignored the undisputed fact that the failure of the fragments to unite was due to some cause with which the treatment administered by the defendants had nothing whatever to do; that is, the failure of Nature to set up the healing process.

But there was one claim of negligence as to which there was sufficient evidence to sustain the finding of the jury, and that was that defendant Voskuil was negligent in not discovering the fact that the injury had not healed at the time of the removal of the extension apparatus, and in the defendant's further failure to call on the patient for

¹Reprinted by permission from *The Journal of the American Medical Association*.

seven or eight days thereafter. However, there was no evidence showing that this in any way contributed to or was a factor in producing the injury complained of.

At the time of the plaintiff's injury there was no roentgenographic apparatus at or near the place where she lived, and there was no suitable electrical current available. Neither did it appear from the testimony that, had a roentgenogram been taken during the treatment, it would have shown that no callus was being formed at the point of fracture. Nor was there cited any case holding that it is as a matter of law negligence for an attending physician and surgeon to fail to avail himself of the use of a roentgenographic apparatus in the case of fracture, and on the facts shown here this Court cannot so hold, particularly as it was comparatively easy to determine whether or not the ends of the bones were in apposition. It is clear that under the facts in this case the failure to procure a roentgenogram during the course of treatment did not amount to negligence or unskillful treatment.

ATTENDING PHYSICIAN NOT LIABLE FOR
CONSULTANT'S FEE

Zumwalt *vs.* Schwarz (Calif.), 297
P.R. 608

Ordinarily, when a person requests another to perform certain services the law implies a promise on the part of that person to pay the reasonable value of the services performed. This rule does not apply, however, where a person requests a physician to perform professional services for some one to whom the person making the request is under no legal obligation to furnish medical aid. Where no such legal obligation exists,

one who calls a physician to attend another is not liable for the services performed in the absence of an express agreement to pay for them. (21 R. C. L. 412, McClenahan *vs.* Keyes, 188 Calif. 574, 206 P. 454.)

An attending physician, therefore, who with the approval of the patient or his family calls in a consulting physician, acts only as the agent of his patient and is not liable for the payment of any part of the consultant's fee. Under the weight of authority, according to the District Court of Appeal, First District, Division 1, California, the financial condition of a patient may be considered by a jury as affecting the reasonableness of a physician's charges. Even in those jurisdictions holding to the contrary, an exception is made that permits the consideration of such evidence where there is proof of a recognized usage that has grown into a custom, to graduate professional charges with reference to the financial condition of the patient, so that it may be considered that services were rendered by the physician and accepted by the patient in contemplation of it. The general custom must be considered in determining the intent of the parties and is in effect a part of the contract between them unless the contract manifests a contrary intention.

PHYSICIAN'S OFFER TO REMEDY RESULT OF
MALPRACTICE IS NOT A DEFENSE

Thackery *vs.* Helfrich (Ohio), 175 N.E.R.
449

The refusal of a patient to allow his physician to perform an operation to remedy damage caused by the physician's allegedly negligent treatment is no defense in an action against the physician for malpractice.

EDITORIAL

LEON J. MENVILLE, M.D. . . . Editor

BUNDY ALLEN, M.D. . . . Associate Editor

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INTRATHORACIC MANIFESTATIONS OF LYMPHOBLASTOMA

Although Malpighi,¹ in the latter half of the seventeenth century, and Morgagni, in 1769, noted a disease or group of diseases which attacked the lymphatic system primarily, Hodgkin² is usually regarded as their collator and attestor. In 1832 he described "some morbid appearances of the absorbent glands and spleen," and recorded seven cases. His junior, Wilks,³ collected 15 cases, and perpetuated Hodgkin's memory by naming the syndrome for him. No attempt was made to distinguish the various members of the group. Virchow, who was the first to make an effort at intelligent classification of the various types originally designated as "Hodgkin's disease," separated lymphosarcoma and the leukemias from the group. The difficulty of accurate classification, even when tissue is available for microscopic examination, has led to the use of the generic terms, "lymphoblastoma" or "malignant lymphoma." Classification of the various types of the disease in one group has the sanction of numerous pathologists, including Mallory,⁴ who believes that they are

different manifestations of one disease, a malignant lymphatic neoplasm.

The nature of lymphoblastoma has long been discussed and, although many theories of its etiology have been propounded, the actual cause is still obscure. The cardinal sign of lymphoblastoma is glandular enlargement. This group of diseases may, however, involve any part of the body. The skin, the gastro-intestinal tract, or the urinary tract, the spleen, liver, kidneys, or lungs may be invaded. The functional integrity of the connective tissues or of the bony framework may be seriously impaired.

The intrathoracic manifestations of lymphoblastoma have been admirably reviewed in the comprehensive work of Kirklin and Hefke.⁵ They found roentgenologic manifestations of intrathoracic disease in 50 per cent of cases of Hodgkin's disease, and in 20 per cent of the cases of lymphosarcoma and of leukemia. Wessler and Greene⁶ found mediastinal involvement in 100 per cent, Whitaker⁷ in 30 per cent (autopsy), and Kruchen⁸ in 65 per cent of the cases of Hodgkin's disease.

The character of the intrathoracic changes in lymphoblastoma is quite variable; there is probably no roentgenologic syndrome distinctive of any one type or of the group. Wessler and Greene distinguished four types of involvement in Hodgkin's disease: the mediastinal tumor; infiltrative type; isolated nodules or metastases in the

¹RICHARD CHUTE: Malignant Lymphoma and the Urinary Tract. *Jour. Am. Med. Assn.*, Oct. 3, 1931, XCVII, 969-971.

²THOMAS HODGKIN: On Some Morbid Appearances of the Absorbent Glands and Spleen. *Med. Chir. Trans.*, London, 1832, XVII, 68-114.

³S. WILKS: Cases of Enlargement of the Lymphatic Glands and Spleen (or Hodgkin's Disease). *Guy's Hosp. Rep.*, London, 1865, XI (3d ser.), 56, 57.

⁴T. B. MALLORY: Discussion of Clinical Case Record. *New England Jour. Med.*, 1928, CXCI, 96, 97.

⁵B. R. KIRKLIN and H. W. HEFKE: Roentgenologic Study of Intrathoracic Lymphoblastoma. *Am. Jour. Roentgenol. and Rad. Ther.*, November, 1931, XXVI, 681-690.

⁶H. WESSLER and C. M. GREENE: Intrathoracic Hodgkin's Disease; Its Roentgen Diagnosis. *Jour. Am. Med. Assn.*, 1920, LXXIV, 445-448.

⁷L. R. WHITAKER: Malignant Lymphoma (Hodgkin's Disease): a Radiographic Study. *Arch. Int. Med.*, October, 1923, XXXII, 538-555.

⁸C. KRUCHEN: Klinik der Lymphogranulomatose mit besonderer Berücksichtigung der Röntgentherapie. *Ergebn. d. inn. Med. u. Kinderh.*, 1929, XXXVI, 407-493.

lung, and discrete nodes at the root of the lungs. They considered the latter the most common type of involvement. To them, the right paratracheal node was of the greatest interest, and its enlargement a diagnostic criterion for Hodgkin's disease. After a review of 26 cases of Hodgkin's disease, Lemon and Doyle⁹ stated: "In general, Hodgkin's disease is suspected when the roentgenogram reveals a bilateral feathery shadow passing outward from each hilum." Whitaker used the classification of Wessler and Greene in 40 cases, and likewise concluded that discrete nodes could be found in the hilum in the majority of cases. Mediastinal tumor was next in frequency, and actual pulmonary infiltration third. He found no case with isolated nodules in the pulmonary parenchyma.

Kirklin and Hefke divide their cases of Hodgkin's disease into two large groups. Group 1 are those in which only the lymphatic glands are involved; in Group 2 are those with pulmonary infiltration, with or without involvement of the nodes. Of their 40 cases, 62.5 per cent could be classified under Group 1, and 30 per cent under Group 2. Of the latter, glandular involvement was absent in only one case. In 65 per cent of all cases a definite shadow of a paratracheal node was visualized on the right side. Of the cases with pulmonary involvement, well defined nodules of the metastatic type were found in 12.5 per cent; the majority showed infiltration into the lungs, originating from the affected nodes. A similar investigation of 17 cases of lymphosarcoma revealed bilateral lobulated mediastinal widening in 10, a unilateral large oval mass in two, localized discrete nodes in four, and pulmonary infiltration in four. In 10 cases of leukemia four were found with definite pulmonary infiltration. Enlarged

nodes were seen in all cases, and discrete nodes in five.

My studies have been limited to 17 cases of lymphoblastoma with intrathoracic changes. Of these, 14 were proved cases of Hodgkin's disease, two of chronic lymphatic leukemia, and one of lymphosarcoma.

In nine of the cases with Hodgkin's disease, there was actual pulmonary infiltration, accompanied in each instance by nodal enlargement in the hilum, mediastinum, or both. The majority of the patients with infiltrative pulmonary lesions had been ill for over a year; it, therefore, seems probable that this type of lesion represents a relatively late stage of the disease. In three instances, a progressive increase in the pulmonary infiltration was demonstrated, in spite of adequate roentgentherapy. The response of this type of lesion to X-ray therapy was usually less satisfactory than that of the cases with pure glandular enlargement. The typical manifestation was a feathery infiltration extending radially from an enlarged hilum. In a majority of cases there was also mediastinal glandular enlargement, but none was visualized in three cases. In only one case was an isolated nodule demonstrated in the pulmonary parenchyma and this did not present the typical appearance of a metastatic nodule. In one case there was complete opacity of the upper two-thirds of the right lung field, suggestive of lobar pneumonia or a primary malignant process. In five cases the intrathoracic changes were limited to glandular enlargements; in two of these, there was extreme bilateral mediastinal widening, as well as hilar enlargement. In one there was less marked widening, and in two the adenopathy was limited to the superior mediastinum.

There was no demonstrable enlargement of the right paratracheal nodes in only four of the group of 14 cases. Right paratra-

⁹W. S. Lemon and J. B. Doyle, Clinical Observations of Hodgkin's Disease with Special Reference to Mediastinal Involvement. *Am Jour Med Sci*, 1921, CLXXII, 516-525.

cheal gland involvement is also frequent in malignant lymphadenopathy, so this cannot be construed as a diagnostic sign of Hodgkin's disease. The left lung root is encircled by the rigid aortic arch and does not permit expansion of enlarged lymph nodes. The right hilum, which is encircled by the less resistant vena azygos major and superior vena cava, offers space for the enlargement of glands. This anatomic peculiarity undoubtedly is a factor in the higher incidence of adenopathy on the right.

In one case of chronic lymphatic leukemia, there was a nodular enlargement in each hilum, with no pulmonary lesion. In the other there was a feathery pulmonary infiltration, but less extensive and more indistinct than that seen in any case of Hodgkin's disease.

In the case of lymphosarcoma, there was an enlargement of the superior mediastinum continuous with a supraclavicular lymphatic tumor.

The relative frequency of involvement of the intrathoracic structures in lymphoblastoma makes it necessary to bear this condition in mind in the diagnostic consideration of any unusual pulmonary, mediastinal, or hilar lesion. Although differential diagnosis of various members of the group may be impossible, it is often possible to recognize the condition as lymphoblastoma. The most important criterion of diagnosis is glandular involvement, and increased prominence of the right paratracheal glands is a common manifestation. In my experience a feathery pulmonary infiltration accompanied by enlargement of the hilar glands is next in frequency. However, the roentgenologic manifestations will necessarily vary according to the stage of the disease.

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ANNOUNCEMENTS

THE COMING ANNUAL MEETING

ATLANTIC CITY'S ADVANTAGES

Atlantic City as a health and pleasure resort is popular the year round. When the Annual Meeting of the Radiological Society of North America is held there, November 28 to December 2, its theme song will be that satisfactory one, "No Snow on the Boardwalk."

Situated on an island which juts out more than six miles into the ocean, Atlantic City is warmed by the Gulf Stream in winter and is, therefore, popular as a resort during the so-called cold months as well as in summer when fanned by ocean breezes. The famous Boardwalk, sixty feet wide, overlooking the sea, is sheltered from any wintry winds from the landward, and is lined for miles on one side with interesting shops and stores of all kinds; on the other side, piers extending a thousand feet or more into the sea are alive with entertainments and music. Lights flank the famous walk and convert it into a veritable fairyland at night. Night promenading or roller-chairing is most enjoyable during the winter months. There are orchestra concerts, dancing in the hotels and on the piers, indoor swimming pools, numerous theaters, "movies" and varied entertainment. In the daytime, one has the choice of a round of golf in the fresh, invigorating sea air; ice skating in the Auditorium, or perhaps a canter on the beach at the ocean's edge.

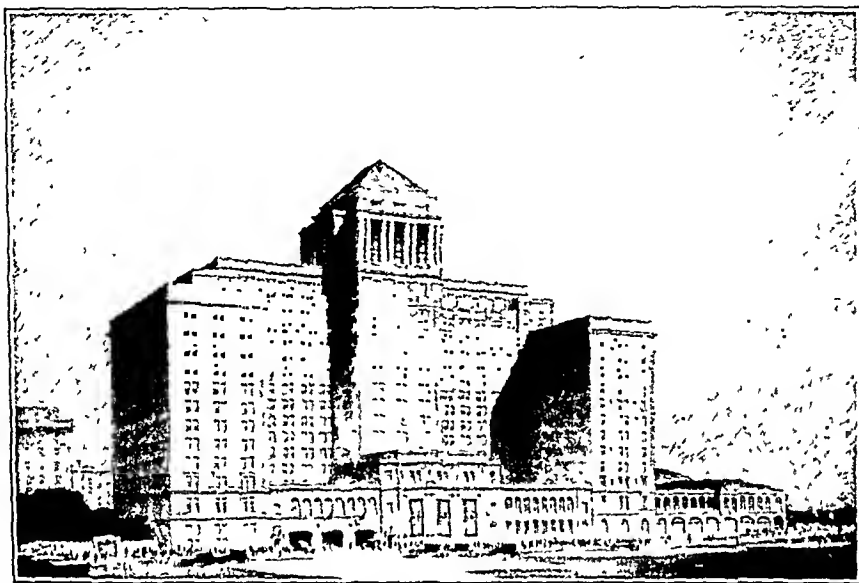
Plans are maturing for one of the best gatherings in the history of the Radiological Society—a meeting which should go down in history for the amount of constructive work accomplished.

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modern hotel, it is small wonder that people come to Atlantic City, and come back again.

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Harold S. Davidson, M.D., President County Medical Society (by invitation), Atlantic City, N. J.

Walt P. Conaway, M.D., Ex-president New Jersey State Medical Society (by invitation), Atlantic City, N. J.

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John S. Irvin, M.D., in charge of publicity for the Atlantic County Medical Society (by invitation), Atlantic City, N. J.

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CO-OPERATION FROM CONTRIBUTORS

The Editor wishes to make grateful acknowledgment to a certain member of the Society who had lightened the task of asking contributors of papers to bear the expense of their illustrations. In reply to one such letter came the following reply:

"There is no help for it but for every one to do the best he can until the sun shines again. You may proceed with the publication of my paper and bill me for the actual cost of the illustrations.

"The clinic with which I am associated does not bear any of the cost of preparation of papers or purchase and mailing of reprints, hence any such cost falls on the individual who has papers published. This has cost me personally quite a bit of money in the last three or four years, but I feel that the stimulus to study and the increased range of articles read has more than compensated me for the money expended. When one works in a small clinic he must either keep up with the work of others or stagnate, and I find that preparing an article for publication necessitates careful study of the literature. . . . It has been difficult to keep our laboratory open, and profit is practically nil."

BOOK REVIEW

CLINICAL ROENTGEN PATHOLOGY OF THORACIC LESIONS. By WILLIAM H. MEYER, M.D., Professor of Roentgenology in the New York Post-graduate Medical School of Columbia University, and Director of Roentgenology in the New York Post-graduate Hospital. Cloth; 272 pages, with 183 illustrations. Published by Lea and Febiger, Philadelphia, 1932. Price, \$6.00.

In a concise and well organized preface, the author sets forth his reasons for recording the material which his book embodies. It is a text-book which shall serve as a record and guide for previous and future students and associates of the Department of Roentgenology of the New York Post-graduate Medical School. Dr. Meyer explains the subsequent contents of each of the book's six sections.

By way of introduction, he discusses the fundamentals of roentgen interpretation. Under this heading, he considers the variations within normal limits, structural density, pathology, postural variations, motion, and the physics of light transmission and ray divergence. Section I is a roentgen study of the thorax, and it is an excellent basic consideration of technic, anatomy, and the locale of possible lesions. Each of the remaining sections is admirably described by its title: II, Roentgen Pathology; III, Diseases Affecting the Thoracic Cage; IV, Special Diseases of the Respiratory System; V, Lesions of the Heart and Pericardium; VI, The Esophagus and Subphrenic Organs in Relation to Intrathoracic Pathology.

The outstanding characteristics of the book are that it is brief, simple, and accurate. The pen-and-ink sketches are very interesting and instructive. It is evident that the book is the work of a man who has had extensive experience in teaching, and consequently, it is especially valuable for the student and beginner. Excellent editing and a complete index augment its availability as a ready reference.

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PAGET'S DISEASE

Radiographic Examination of a Paget's Skull. L. Rocher and Ch. Lasserre. *Arch. de l'Électricité méd.*, July, 1931, XXXIX, 241-244.

The authors examined roentgenograms of a skull, affected with Paget's disease, from the anatomic collection of the School of Medicine of Turin.

It was observed that in the lateral view the vertical diameter was decreased and the anteroposterior diameter was increased when compared to a normal skull. The total capacity of the affected skull remained unchanged, however, for the loss in the vertical dimension was compensated for by gain in the anteroposterior. The vault appeared very much thickened and condensed, varying from 2 to 3 centimeters. The internal table was distinct in the frontal and occipital regions, and the contour of the external table was equally clear throughout. Several lacunæ were evident in the region of the external table in the parietal and occipital areas, and a small island of bone surrounded by a rarefied zone was observed in the frontal region. Thus, areas of increased and decreased density were found side by side.

The lesions of the base were considered characteristic. The entire base, with the exception of the occipital foramen, appeared to be depressed and flattened, and the cerebellar fossa was reduced in size. The anterior cerebral fossa and the sella turcica, however, appeared unchanged. No changes were found in the frontal sinuses or in the bones of the face.

The anteroposterior view revealed very conspicuous changes and some asymmetry in the parietal regions. A small island of condensed bone, surrounded by a spongy area with a sharp line of demarcation, was noted on the left. A roentgenogram made in the position of Hirtz showed the occipital foramen narrowed, with marked thickening of bone along its margin.

J. N. ANÉ, M.D.

A Contribution to Osteodystrophia Generalisata (von Recklinghausen). F. Schmidt. *Röntgenpraxis*, Jan. 15, 1932, IV, 59-67.

Osteitis deformans (Paget's), osteitis fibrosa generalisata (von Recklinghausen), osteitis localisata, and leontiasis ossea are considered by most authors to be of the same origin and are often called osteitis fibrosa. Recently, some authors want to separate Paget's from Recklinghausen's disease as an entirely distinct entity. The latter is supposed to be a hyperparathyroidism (hyperealemia, hyperphosphaturia and increase in calcium excretion in the urine).

A case of osteitis fibrosa generalisata in a 12-year-old boy is described in detail, and several illustrations show the bone changes which were present in a characteristic picture of cystic destruction in many bones. There was an excessive excretion of cal-

cium in the urine, but no other evidence of hyperparathyroidism. Surgery or autopsy reports were not available for further information.

H. W. HEFKE, M.D.

RADIATION INJURIES

Quality of Rays, Roentgen Illness, and the Red Blood Picture. Dietel. *Schweiz. med. Wchnschr.*, April 16, 1932, LXII, 386, 387.

Clinical observations led to the question of whether, in addition to the intensity and region of irradiation, the quality of radiation might play a part in the development of roentgen sickness. The author experimented with: (1) Radium filtered through 1 mm. brass; (2) X-rays 180 K.V., 2.5 mm. Cu; (3) X-rays 170 K.V., 1 mm. Cu; (4) X-rays 125 K.V., 0.3 mm. Cu. The distance was kept constant at 50 centimeters. The soft irradiation (4) produced the most severe reaction, even when the intensity (r per minute) was the same as in (3). The first and second types of irradiation were borne best.

Studies of the blood carried out for five hours after irradiation revealed a diminution in erythrocytes proportional in many cases to the amount of roentgen intoxication. There was only a slight diminution of hemoglobin, and consequently an increase in the color index. Injection into guinea pigs of serum of patients who had roentgen illness produced a marked diminution in erythrocytes. The author feels that this reaction is due to a toxic material in the blood or in irradiated tissues. He found no evidence that it might be due to ozone or nitrous compounds in the air. On the whole, hard rays of not too great intensity are best tolerated.

H. C. OCHSNER, M.D.

A Roentgen Carcinoma Healed by Radium. A. H. Roffo. *Strahlentherapie*, April 13, 1932, XLIII, 757-766.

The author discusses in general the use of radium in the treatment of roentgen carcinoma and appends the report of a radiologist, written by the latter, who had been suffering for about 20 years from chronic radiodermatitis of both hands, with definite malignant degeneration. In October, 1930, all lesions were treated by radium (exact dosage given in the paper). They healed within 2 months' time and have remained well for a year. Photographs of the hands before and after treatment are appended.

ERNST A. POHLE, M.D., Ph.D.

RESPIRATORY TRACT

A Graphic Method of Recording the Respiratory Excursion of the Diaphragm. Harold Thomas. *Am. Jour. Roentgenol. and Rad. Ther.*, December, 1931, XXVI, 878-880.

A relatively simple technic has been devised for

obtaining on a single film of the chest the diaphragmatic excursions and the change in position of the mediastinal contents and ribs. Such a radiographic study should be particularly helpful in any case which cannot be moved to the fluoroscopic room, in which some lesion in the vicinity of the diaphragm is suspected. In order to obtain good contrasting density of the diaphragm outlines at the two levels, three-fourths to seven-eighths of the chest exposure should be made, with the breath held at expiration, and only one-fourth to one-eighth of the exposure made at held inspiration.

J. E. HABBE, M.D.

Acute Silicosis. Earle M. Chapman. Jour. Am. Med. Assn., April 23, 1932, XCVIII, 1439-1441.

This is a report of three cases of acute silicosis following comparatively short exposure to alkaline silica mixtures in the manufacture of scouring soaps. The appearance of respiratory symptoms after eight, twenty-one, and twenty-nine months of exposure to an alkaline dust of high silica content marks a more rapid and severe silicosis than is usual. MacDonald reported rapidly fatal cases in two young girls employed for two and one-fourth years packing a similar type of soap. Acute silicosis is a real industrial hazard, hitherto unrecorded in the medical literature in this country.

C. G. SUTHERLAND, M.D.

Some Considerations of the "Standardized" Technic in the Radiologic Examination of the Respiratory Tract. F. Bruno Omizzolo. Archivio di Radiologia, January-February, 1932, VIII, 81-91.

The author points out the fact that in radiography of the chest there are many "standard" techniques, some using low voltage and some high voltage at widely varying target skin distances with and without diaphragms. A good radiograph should have the following qualities: definition, richness of detail, contrast, and conservation of dimensions. He shows that there is no universal standard but that each radiologist uses his own technic and that it would be desirable to have some fixed conditions established and accepted.

E. T. LEDDY, M.D.

THE SKIN (THERAPY)

The Radiation Treatment of Some Skin Affections. C. M. Henry. Canadian Med. Assn. Jour., December, 1931, XXV, 702-704.

Many skin affections which do not respond to ordinary therapy will clear up under radiation therapy. It is just as important to make a correct diagnosis in skin affections before beginning radiation treatment, as it is if any other type of treatment is being used. Skin affections, due to focal infections of the teeth, adenoids, sinuses, gastro-intestinal, trinal, or prostatic

conditions, also those due to addiction or susceptibility to drugs or toxins from without, or to deficiency or overaction of secretory glands within the body, must be eliminated. Diabetic and nervous disturbances also require careful scrutiny.

Aene, in its various forms, is one of the most common infections. When it does not respond to medical, dietetic, or serum treatment, it will often respond to radiation therapy. Whether the infection is local or general, good results are obtained by a combination of ultra-violet and X-ray treatment. The patient is given one-sixth of an erythema dose of X-rays every five to seven days, for four or five exposures; then exposure to the mercury quartz lamp at a 20-inch skin distance, 70 ma., to effect a skin erythema, every second or third day, and continued for a period of two or three weeks.

Impetigo, when treated at the beginning of an infection, will usually be cured by one-fourth of an X-ray erythema dose, but if the infection has been present for several days, quicker results are obtained by the combination of X-rays and quartz lamp. One exposure of X-rays, followed by the lamp at two-day intervals, will clear up the condition.

Eczema is the result of a skin idiosyncrasy to precipitating causes. It often responds to radiation therapy when all other measures fail. Either X-ray or quartz lamp or a combination of both may be used. Careful judgment must be exercised in treating the acute forms by radiotherapy.

Psoriasis will often respond to the quartz lamp applied very closely or in contact, the water-cooled lamp being used. If the disease is widespread over the body, the combination of X-rays and quartz lamp will produce good results, but a tendency to relapse is very frequent. Treating the ovary, pituitary, thyroid, and suprarenal glands with the X-ray will often result in a cure when general radiation fails.

Furunculosis and carbuncles may be aborted if the treatment by X-rays is given in the inflammatory stages, but if pus is present it is advisable to incise and then treat with the X-ray.

Warts, corns, and moles disappear when rather heavy unfiltered doses of X-rays are given. The surrounding skin area must be protected by lead. X-rays are a specific cure for plantar warts.

Erysipelas is not relieved so specifically and effectively by any other measure as by the X-ray. One exposure will give results as surprising and immediate as when antitoxin is administered for diphtheria. The earlier the treatment is given the quicker the results.

Actinomyces and blastomycosis may be benefited and often cured by repeated treatments of X-rays of moderate dosage. The assistance of full doses of potassium iodide is also valuable in ray-fungus conditions.

Nevi are better treated by a radium plaque or

pack, as it is difficult to keep a child quiet for X-ray treatment. When radium is used, it is necessary to repeat the treatment at two or three monthly intervals until the desired result is obtained. X-ray therapy may often be employed in one dose. For some nevi surgical diathermy is advisable. Port-wine marks are not usually amenable to any form of therapy.

Keloid is favorably influenced by either radium or the X-ray. The dense fibrous types require treatment every two or three months over an extended period of time.

Alopecia areata yields, in many cases, to the ultraviolet rays. The technic is to use the water-cooled lamp, applied at a distance of one-half inch from the area, administering a full erythema dose twice, at three-day intervals. This is repeated for three or four series at two weekly intervals.

Adenoma will receive benefit from X-ray exposures of moderate intensity, whether it be due to tuberculosis, Hodgkin's disease, lymphosarcoma, or some form of blastomycosis, or to thyroid intoxication. Treatments should be applied at intervals of a few weeks.

Rodent ulcers, senile keratosis, squamous epithelioma, and endothelioma of the skin yield readily to X-ray and radium therapy, and the results are likely to be more lasting than if surgery is employed, while there is no resulting deformity and no mortality. The percentage of clinical cures is higher than by any other known method of treatment.

L. J. CARTER, M.D.

Indications for Roentgentherapy in Skin Diseases. Stefan R. Brünauer. *Strahlentherapie*, April 13, 1932, XLIII, 601-630.

This excellent article unfortunately does not lend itself to abstracting, but is well worth reading in the original or in translation. It offers a most complete analysis of the principles underlying the application of roentgen rays in the treatment of skin diseases. There is hardly a dermatologic condition omitted, and the paper is heartily recommended for study in the original.

ERNST A. POHLE, M.D., Ph.D.

A New Indirect Method for Roentgenotherapy of Dyshydrosis and Eczema. D. v. Kémeri. *Strahlentherapie*, March 9, 1932, XLIII, 597-600.

The author believes that in most cases of dyshydrosis and certain types of eczema there exists a focal infection with an organism. Tonsils, periapical abscess, pyorrhea, sinusitis, otitis, prostatic abscess, appendicitis, or cystitis may represent the focus of infection. He observed many cases in which dyshydrosis and eczema promptly disappeared after these foci had been cleared up. Latent processes in

the hilum or in the lungs were also seen in this group. In several cases the author succeeded in activating the pathologic process. The hilum were treated with 30 per cent H.E.D. (120 K.V., 0.5 mm. Zn). The anterior field was given first; the posterior field one week later. In suspected sinusitis and prostatitis 60 per cent H.E.D. were given through 1 mm. Al. The method is recommended to radiologists for trial and study.

ERNST A. POHLE, M.D., Ph.D.

Morphology and Roentgenographic Technic of the "Fissura Orbitalis Inferior" and of the Adjacent Parts. Giuseppe Bartel. *La Radiologia Medica*, December, 1931, XVIII, 1541-1570.

Exact interpretation of the details of a roentgenographic image of the cranium demands profound familiarity with the corresponding anatomic substratum. In addition, account must be taken of the laws of projection and absorption.

On the basis of diagrams of various projections, the author illustrates certain fundamental ideas as regards roentgenologic examination of the cranium in general, and discusses at length the projection with oblique rays, as used in studying the cranium. This method, it is claimed, renders accessible to roentgenologic investigation the lateral and posterior portions of the orbit, not otherwise subject to delineation. This is followed by an exact anatomic description of the *fissura orbitalis inferior* based on personal study through appropriate roentgenographic projection, which promises to be of distinct diagnostic value in studying the pathology of the region in question.

W. W. WHITELOCK, Ph.D.

THE SPINE (DIAGNOSIS)

Teleroentgenograms of the Vertebral Spine. W. Jaeger. *Röntgenpraxis*, March 1, 1932, IV, 193-209.

Teleroentgenograms of the heart and lungs were introduced in 1903 by Köhler and are used in almost all institutes. Baer introduced the same technic (1.5-meter distance) for the vertebral spine. The author has used it since 1929, and gives a critical review of the whole question. A 10-kilowatt roentgen tube is necessary for such work. The broad focus is compensated for by the great distance. The skin exposure (with 0.5 mm. of aluminum as filter) compares favorably with the old technic. Fixation of the patient is very important, as the exposure time is necessarily rather long. The author uses special apparatus for it. The details must be read in the original article. The quality of such roentgenograms is worth the extra time and effort; details are fine and there is no distortion. Unquestionably, there is still room for further improvement in this field.

H. W. HEFKE, M.D.

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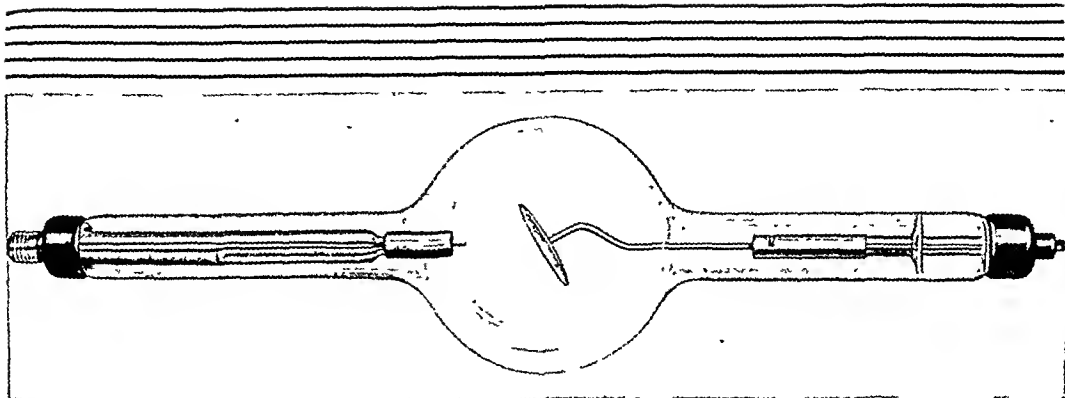
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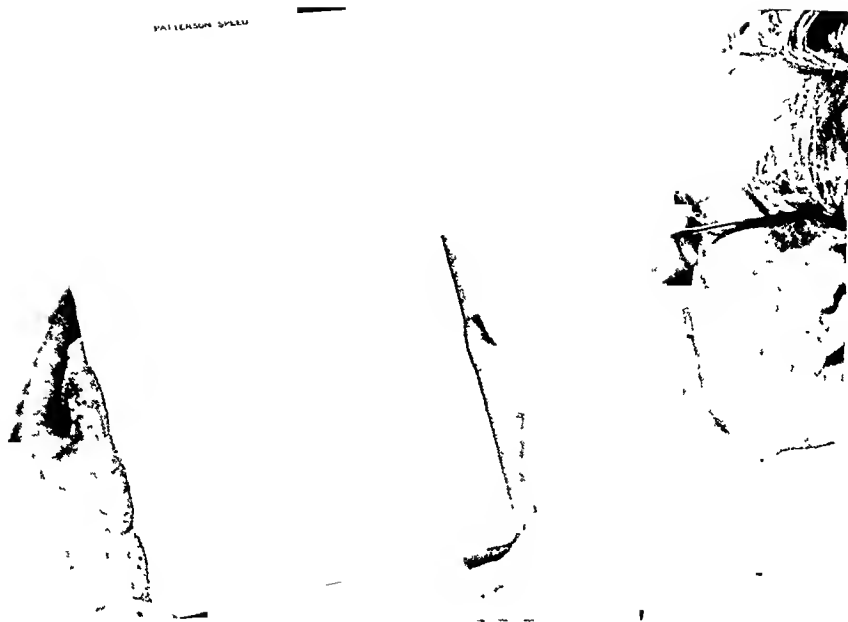
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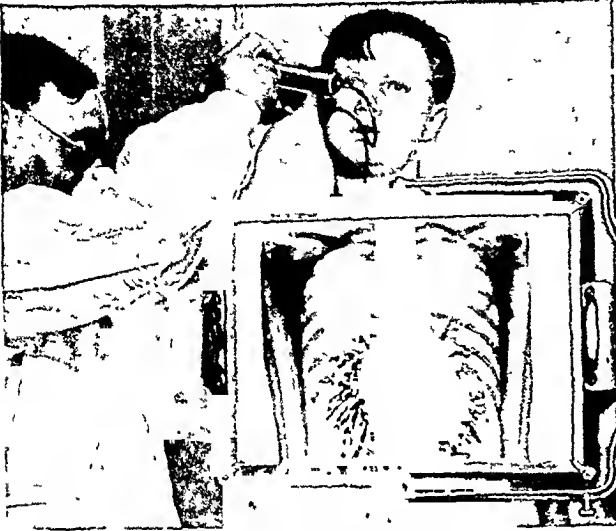


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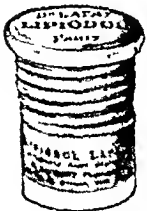
"The best medium for this purpose is iodized poppyseed oil 40% (lipiodol)."

—Samuel Iglauer, M.D.

Journal A. M. A., Vol. 97, No. 21

In this paper, originally read before the Section on Laryngology, Otology and Rhinology of the American Medical Association, Dr. Iglauer states: "The practice of introducing radiopaque substances into the bronchi for diagnostic purposes is now thoroughly established. This is particularly true in the case of adults, but bronchography has not been so generally adopted in children, chiefly because of the difficulty in obtaining the cooperation of these young patients

"While the ordinary roentgenogram of the chest is of great diagnostic value, there are many lesions that can be visualized with much greater certainty and clarity after the introduction of opaque substances. The best medium for this purpose is iodized poppy-seed oil 40 per cent (lipiodol), since it is practically non-toxic, easily manipulated, and very opaque to the x-rays. The value of bronchography is demonstrated particularly in cases of bronchiectasis. The opaque oil not only renders the cavities visible but also shows their approximate shape, number, size and distribution."



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Iglauer's Conclusions

1. The injection of iodized poppy-seed oil into the bronchi clearly demonstrates many lesions which are obscure in the ordinary roentgenogram.

(Elsewhere in his article Dr. Iglauer definitely refers to LIPIODOL (Lafay), the original French iodized oil.)

2. Studies in recent years have demonstrated that many chronic pulmonary diseases begin during childhood.

3. Early diagnosis is of great importance if any marked progress is to be made in the treatment of non-tuberculous pulmonary infections in children.

4. Of the various methods available for bronchography in children, the use of the intubation tube is the most practical, especially since it can be carried out by any physician who can perform intubation.

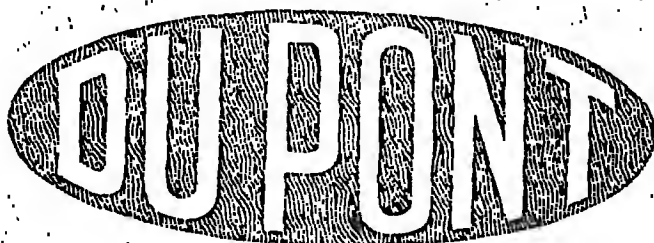
5. Bronchography and fluoroscopy should be carried out at the same time.

6. If positive bronchographic results are obtained, it is usually advisable to examine the bronchi with the bronchoscope before beginning treatment.

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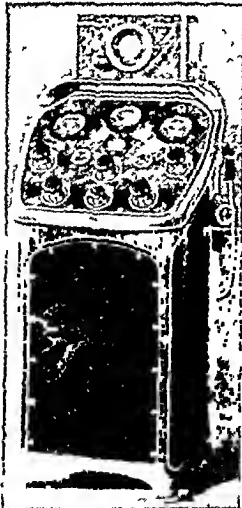
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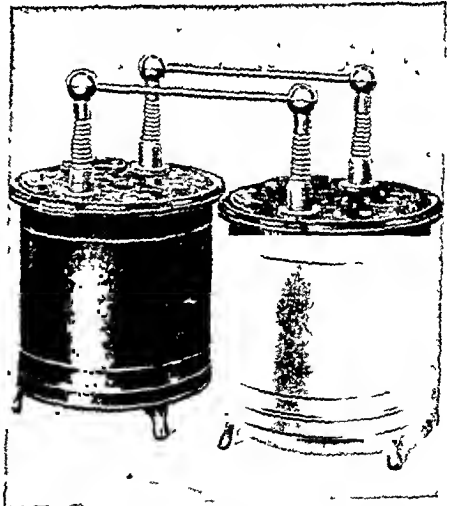
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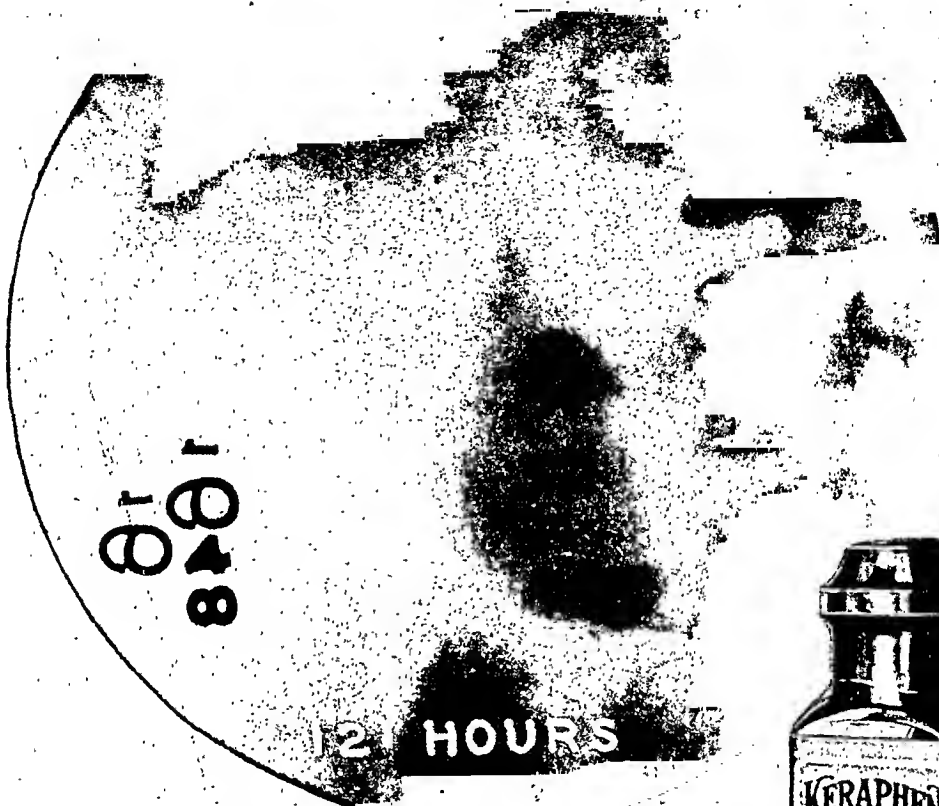
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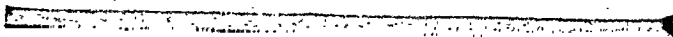
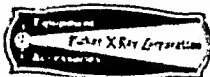
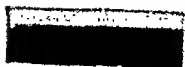
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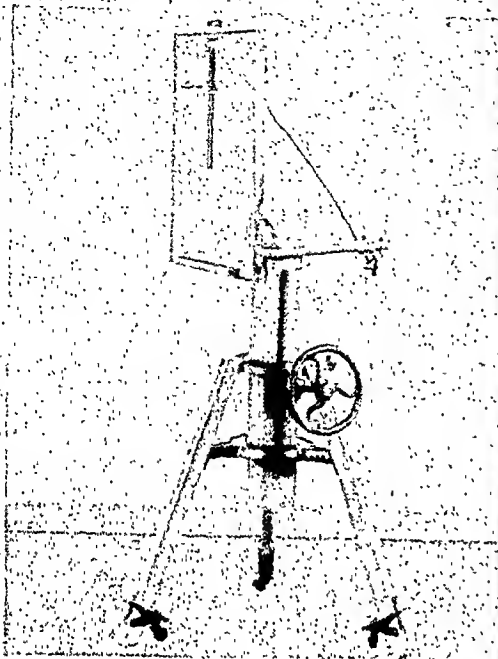
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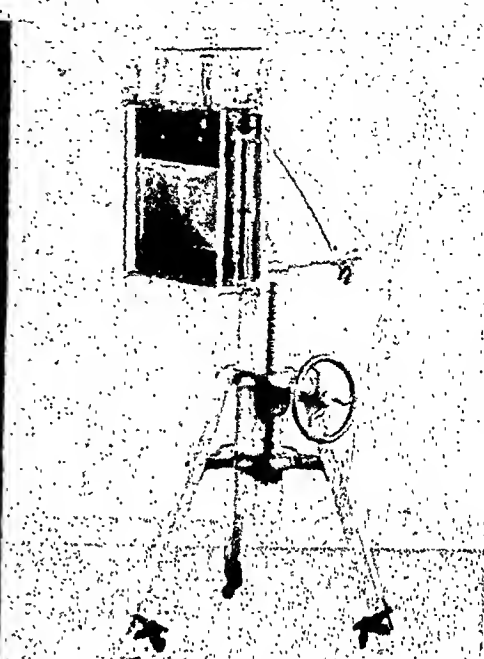
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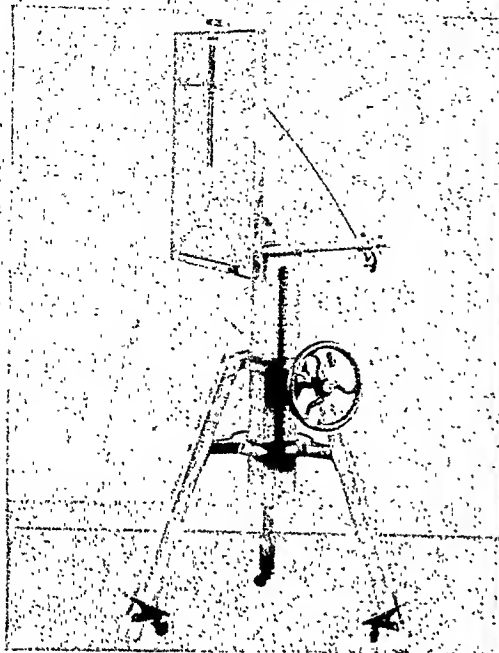


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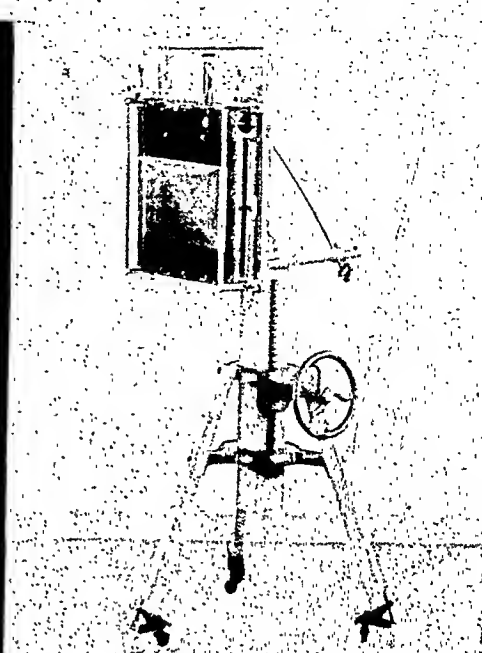
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A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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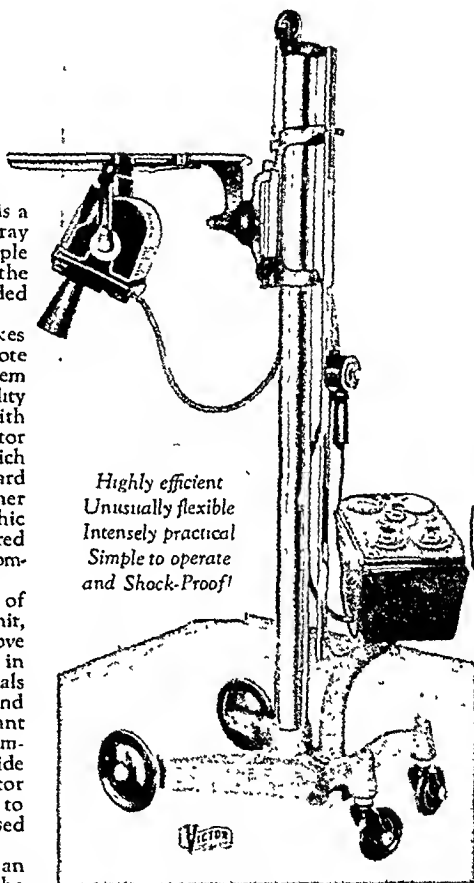
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ROENTGEN DIAGNOSIS OF DISEASES AND ABNORMALITIES OF THE COLON¹

By JOHN L. KANTOR, M.D., NEW YORK CITY

THE roentgen examination is undoubtedly the most useful method yet devised for the objective investigation of the colon. It should, however, be remembered that the colon study constitutes but one part of a complete examination of the digestive tract and that the ideal procedure is to study the entire alimentary canal as a unit by all available methods, no matter whether the symptoms suggest that the trouble lies in the colon or elsewhere in the digestive system. Furthermore, a proper study of the colon must be founded on sound physiologic principles, and, since the emptying time of the human large intestine is a matter of days rather than of hours, one must be prepared to devote an adequate amount of time to this work. It is always well to adopt a systematic order of procedure and to employ it routinely and conscientiously in all cases, unless one is prevented by special considerations from doing so.

TECHNIC

The modern technic of colon examination is based on the solid foundation prepared by such pioneers as Rieder, Holzknecht, Haenisch, Hurst, Schwarz, Stierlin, Carman, Mills, Case, and A. W. Fischer. Among in-

dividual roentgenologists, there is naturally much variation in the details and order of procedure. This variation depends not only on the special interests and skill of the operator, but also largely on the type of material studied, whether acute or chronic, medical or surgical, ambulatory or hospital, public or private.

Our technic, though undoubtedly far from ideal, is deemed best suited to the needs of the average private patient who complains of digestive disorder. It is believed that the procedure recommended will be found adequate not only for the detection of organic disease, but also for the recognition and study of the early pathologic physiology and anomalies of the colon.

Whenever possible, the colon study should constitute a part of a general gastrointestinal examination, the other elements of which should include: history, physical examination, X-ray study of the upper alimentary tract, and such additional tests as may be necessary. In roentgenographic examination of the colon, two chief forms of procedure are available, the opaque meal and the opaque enema. The latter gives information primarily of colonic form, the former of colonic function. Each method beautifully supplements the other and both are needed for a complete investigation. In most cases, it is best to begin the examina-

¹Read before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

tion by filling the colon from above. The standard barium mixture is employed, the observation on the colon commencing five hours after the ingestion of the opaque substance. At this time, the normal stomach is empty and the head of the barium column should reach the cecocolon. When this observation is completed, the patient should be given precise instructions for the remainder of the colon examination. The first essential is that no cathartics, enemas, irrigations, or suppositories be used to produce an artificial bowel action. On the other hand, every spontaneous stool should be recorded by the patient and the total for the 24 hours reported at each observation. It is also important that the patient continue his regular occupation and follow his ordinary diet during the period of study, if possible. He should not be permitted to practise any arbitrary food restrictions, but should be encouraged to eat well of all ordinary foods, so that a proper degree of stimulus may be made available for spontaneous bowel action. It is a good plan to check up on the food intake by a record of daily weighings.

The examination is continued by making an observation every 24 hours after the ingestion of barium until the colon and rectum are entirely free of opaque material. It is good practice to record on each film the interval following the original meal and the total number of spontaneous stools passed by that time.

During the observation of the progress meal it is important to prevent the development of a hard rectal impaction. It is probably no exaggeration to say that failure to do so tends to discourage wider public acceptance of gastro-intestinal X-ray examinations. Although it is unlikely that the opaque meal can of itself initiate rectal impaction, it can certainly aggravate the condition when a tendency to dyschesia exists. Unfortunately, such a tendency is common as, in 844 cases in which the manner of co-

lon emptying was carefully observed, it was encountered in over 18 per cent. Hence, the following recommendations may be of value. As soon as a suggestion of packing is noted, the well-lubricated gloved finger should be introduced into the rectum to determine the density of the barium-fecal mass. As a rule, the rectal contents do not pack down to any appreciable hardness until 48 hours after the meal. At this time, particularly if no spontaneous stool has occurred to justify further waiting, the impaction should be broken up with the finger and two small bulbfuls of oil should be injected and retained for 10 minutes. Then an enema of one and one-half quarts of physiologic salt solution should be administered and the patient permitted to move the bowels. This procedure may have to be repeated once or twice to relieve the condition.

After the colon is seen to be entirely empty of barium, whether spontaneously or in the manner just described, the so-called nine-hour observation is made.² The patient is required to take a second barium meal, exactly as the first, at 8 A.M. It is consumed at home and constitutes the entire breakfast. One hour after the stomach is known to be empty—*i.e.*, six hours after the barium meal, in normal cases—the patient takes his usual lunch. He reports to the laboratory at 5 P.M., when the nine-hour observation is made. This test, one of the most useful single procedures in the study of the colon, reveals the presence or absence of ileal stasis, the type of filling of the cecocolon, the presence or absence of colitis, and the position and mobility of the cecum and hepatic flexure. For the mobility determinations, films made in both prone and erect positions are necessary.

In short, the barium meal procedure is

²Naturally, the nine hour observation may be carried out on the original barium meal if time is available and the condition of the patient permits so long an observation on the first day of the study.

particularly useful in studying the function of the colon in general and in identifying such special conditions as atony, spasticity, irritability, and the various forms of constipation. It is the best means of recognizing anomalies of the proximal large intestine. The method also gives information, but less complete, concerning organic diseases of the colon and anomalies affecting its distal portion.

On the day following the nine-hour observation, the opaque enema is administered. Preliminary preparation: at 7 A.M. the patient is directed to take two or three saline enemas in succession in order to clear the bowel and to remove all traces of barium. He breakfasts at about 8 A.M. and reports for examination at 9 or 10 o'clock. The enema proper is made up of one ordinary glassful of barium sulphate and three-quarters of a glassful of kaolin stirred up in one and one-half quarts (48 ounces) of water. If more bulk is needed, it is made up in the same proportion. The mixture, heated to 110 degrees Fahrenheit, is delivered from a two-quart enema can suspended 2 feet above the level of the fluoroscopic table. An 8-foot run of rubber tubing and a hard rubber rectal tip, 1.5 inches long, 3/16 inch bore, complete the outfit. The usual preliminary precautions—running fluid through the tubing system to expel air, and the introduction of the well-lubricated tube tip by sight rather than by touch—should not be forgotten. The warm fluid is now allowed to flow into the rectum under accurate fluoroscopic control. At the first sign of discomfort on the part of the patient the flow is stopped until the spasm passes. Physiologic delays may be expected at the pelvic-rectal, splenic, and hepatic flexures. The filling of the bowel proceeds in this interrupted manner until the cecum is reached. A film is then made and the patient is permitted to expel the enema. Note is made of the amount of fluid required to fill the co-

lon, of the degree of pain experienced, and of the rate of flow. After the patient's bowels have moved, a second film is made to record the details of evacuation. It goes without saying that both fluoroscopy and radiography should be carried out on the same table.

Some observers (Haenisch, Bryant) prefer to follow the evacuation of the colon under fluoroscopic control in order to obtain a better idea of the physiology of bowel emptying. This can be readily done just after the colon is entirely filled by lowering the enema can, the tube being still in the rectum, and allowing the contents of the bowel to flow out by gravity as well as by muscular effort. Films may be taken at will during this procedure.

Following the opaque enema a contrast enema may be administered, a procedure developed by Fischer. It consists of injecting air into the colon on top of whatever residue of barium remains after the expulsion of the opaque enema. Details within the bowel lumen can be better demonstrated by this than by the usual opaque enema. The equipment required is of the simplest. The same type of tip and tubing is employed as is used for the opaque clysis. To this is fitted a bulb for the air injection. A bulb of the Politzer bag type has been found satisfactory. The air is injected, as was the fluid, under accurate fluoroscopic control and the filling is discontinued when the cecum is reached. Incidentally, I have been impressed by the great distensibility of the cecum with air as compared with fluid. Films are made in the prone and in the right and left lateral positions as needed.

Another advance in technic which permits of the discovery of early and small lesions is the compression method of Berg. The procedure is based on the principle of minimal filling of the lumen with opaque material and graded pressure from without, in order to bring out the mucosal relief with

tion by filling the colon from above. The standard barium mixture is employed, the observation on the colon commencing five hours after the ingestion of the opaque substance. At this time, the normal stomach is empty and the head of the barium column should reach the cecocolon. When this observation is completed, the patient should be given precise instructions for the remainder of the colon examination. The first essential is that no cathartics, enemas, irrigations, or suppositories be used to produce an artificial bowel action. On the other hand, every spontaneous stool should be recorded by the patient and the total for the 24 hours reported at each observation. It is also important that the patient continue his regular occupation and follow his ordinary diet during the period of study, if possible. He should not be permitted to practise any arbitrary food restrictions, but should be encouraged to eat well of all ordinary foods, so that a proper degree of stimulus may be made available for spontaneous bowel action. It is a good plan to check up on the food intake by a record of daily weighings.

The examination is continued by making an observation every 24 hours after the ingestion of barium until the colon and rectum are entirely free of opaque material. It is good practice to record on each film the interval following the original meal and the total number of spontaneous stools passed by that time.

During the observation of the progress meal it is important to prevent the development of a hard rectal impaction. It is probably no exaggeration to say that failure to do so tends to discourage wider public acceptance of gastro-intestinal X-ray examinations. Although it is unlikely that the opaque meal can of itself initiate rectal impaction, it can certainly aggravate the condition when a tendency to dyschesia exists. Unfortunately, such a tendency is common as, in 844 cases in which the manner of co-

lon emptying was carefully observed, it was encountered in over 18 per cent. Hence, the following recommendations may be of value. As soon as a suggestion of packing is noted, the well-lubricated gloved finger should be introduced into the rectum to determine the density of the barium-fecal mass. As a rule, the rectal contents do not pack down to any appreciable hardness until 48 hours after the meal. At this time, particularly if no spontaneous stool has occurred to justify further waiting, the impaction should be broken up with the finger and two small bulbfuls of oil should be injected and retained for 10 minutes. Then an enema of one and one-half quarts of physiologic salt solution should be administered and the patient permitted to move the bowels. This procedure may have to be repeated once or twice to relieve the condition.

After the colon is seen to be entirely empty of barium, whether spontaneously or in the manner just described, the so-called nine-hour observation is made.² The patient is required to take a second barium meal, exactly as the first, at 8 A.M. It is consumed at home and constitutes the entire breakfast. One hour after the stomach is known to be empty—*i.e.*, six hours after the barium meal, in normal cases—the patient takes his usual lunch. He reports to the laboratory at 5 P.M., when the nine-hour observation is made. This test, one of the most useful single procedures in the study of the colon, reveals the presence or absence of ileal stasis, the type of filling of the cecocolon, the presence or absence of colitis, and the position and mobility of the cecum and hepatic flexure. For the mobility determinations, films made in both prone and erect positions are necessary.

In short, the barium meal procedure is

²Naturally, the nine hour observation may be carried out on the original barium meal if time is available and the condition of the patient permits so long an observation on the first day of the study.

particularly useful in studying the function of the colon in general and in identifying such special conditions as atony, spasticity, irritability, and the various forms of constipation. It is the best means of recognizing anomalies of the proximal large intestine. The method also gives information, but less complete, concerning organic diseases of the colon and anomalies affecting its distal portion.

On the day following the nine-hour observation, the opaque enema is administered. Preliminary preparation: at 7 A.M. the patient is directed to take two or three saline enemas in succession in order to clear the bowel and to remove all traces of barium. He breakfasts at about 8 A.M. and reports for examination at 9 or 10 o'clock. The enema proper is made up of one ordinary glassful of barium sulphate and three-quarters of a glassful of kaolin stirred up in one and one-half quarts (48 ounces) of water. If more bulk is needed, it is made up in the same proportion. The mixture, heated to 110 degrees Fahrenheit, is delivered from a two-quart enema can suspended 2 feet above the level of the fluoroscopic table. An 8-foot run of rubber tubing and a hard rubber rectal tip, 1.5 inches long, 3/16 inch bore, complete the outfit. The usual preliminary precautions—running fluid through the tubing system to expel air, and the introduction of the well-lubricated tube tip by sight rather than by touch—should not be forgotten. The warm fluid is now allowed to flow into the rectum under accurate fluoroscopic control. At the first sign of discomfort on the part of the patient the flow is stopped until the spasm passes. Physiologic delays may be expected at the pelvic, splenic, and hepatic flexures. The filling of the bowel proceeds in this interrupted manner until the cecum is reached. A film is then made and the patient is permitted to expel the enema. Note is made of the amount of fluid required to fill the co-

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mediately above this junction point is a narrowing, demonstrable in only a few individuals, which corresponds to a rudimentary cecocolic sphincter (Hirsch). The ascending colon ends at the hepatic flexure, which is located in a general way at the liver edge, but its precise position is sometimes difficult to define, especially in sthenic individuals. The transverse colon usually bends downward, at times into the pelvis, and in its distal portion follows closely the greater curvature of the stomach. The splenic flexure usually lies under and just within the tip of the spleen, but it may occasionally reach the left diaphragm. Rarely, it is on a lower level than the hepatic flexure. The descending colon terminates at the iliac crest. Here it joins the iliac colon, which traverses the iliac bone to continue as the pelvic colon when the brim of the pelvis is passed. The pelvic colon is the most variable part of the large intestine in length. Kinks occur most commonly in the iliac and pelvic portions. The pelvic colon joins the rectum in a sharp angle (pelvirectal junction) at the level of the midsacrum.

The haustral arrangement of the normal colon is distinctive. It is best seen after an opaque meal, when the haustrations are found to extend from the ascending colon to the rectum, being best marked in the transverse colon. In the usual roentgenogram, only two of the three rows of haustrations are visualized, the posterior being completely hidden by the upper row and the central axis of the colon. When normal, the haustra are evenly balanced and spaced, that is, the bowel lumen is central and the sacculi on either side are approximately equal in size and symmetry. Ordinarily, the penetration between adjacent haustra is from one-half to two-thirds the diameter of the colon.

After a barium meal, the postural tone of the colon is well revealed graphically. Normally the proximal colon is wider than the

distal in the proportion of about 3 to 2. The opaque enema is also adapted to this demonstration. The normal bowel requires an average of 38 ounces to fill to the cecum. The inflow, which is fairly uniform in rate, takes from two to four minutes for completion. There should be no pain, but, by the time the cecum is reached, a distinct call to defecation should be present.

The normal rates for the filling and emptying of the colon (Fig. 1) after a barium meal are, according to our experience:

At four hours the head of the barium column should reach the cecum.

At five hours the stomach should be empty and the head of the column should reach the vicinity of the hepatic flexure.

At nine hours the ileum should be empty and the head of the column should reach the vicinity of the splenic flexure.

At twenty-four hours the entire circuit of the colon should be completed, the bowels should have moved, usually with barium in the stool, and the cecum should begin to clear.

At forty-eight hours, the bowels should have moved again, this time with barium definitely in the stools, and the cecocolon (proximal colon) should be empty. Traces of barium may or may not persist in the distal colon and rectum.

At seventy-two hours, the bowels should have moved again and the colon and rectum should be entirely clear of barium.

ORGANIC DISEASES

Obstruction.—The particular method to be used for the diagnosis of colonic obstruction depends essentially on the acuteness of the process. Generally speaking, obstruction in the large bowel is a less severe menace than it is in the small intestine; hence, somewhat more deliberation is permissible in the examination. However, in the face of complete obstruction, no matter where it is located, speed is essential. Under such

the greatest possible wealth of detail. The observation is best made after the expulsion of the opaque enema with, or without, the ritability, particularly in its more advanced stages. In general, the enema is especially valuable because of its speed, for it can be

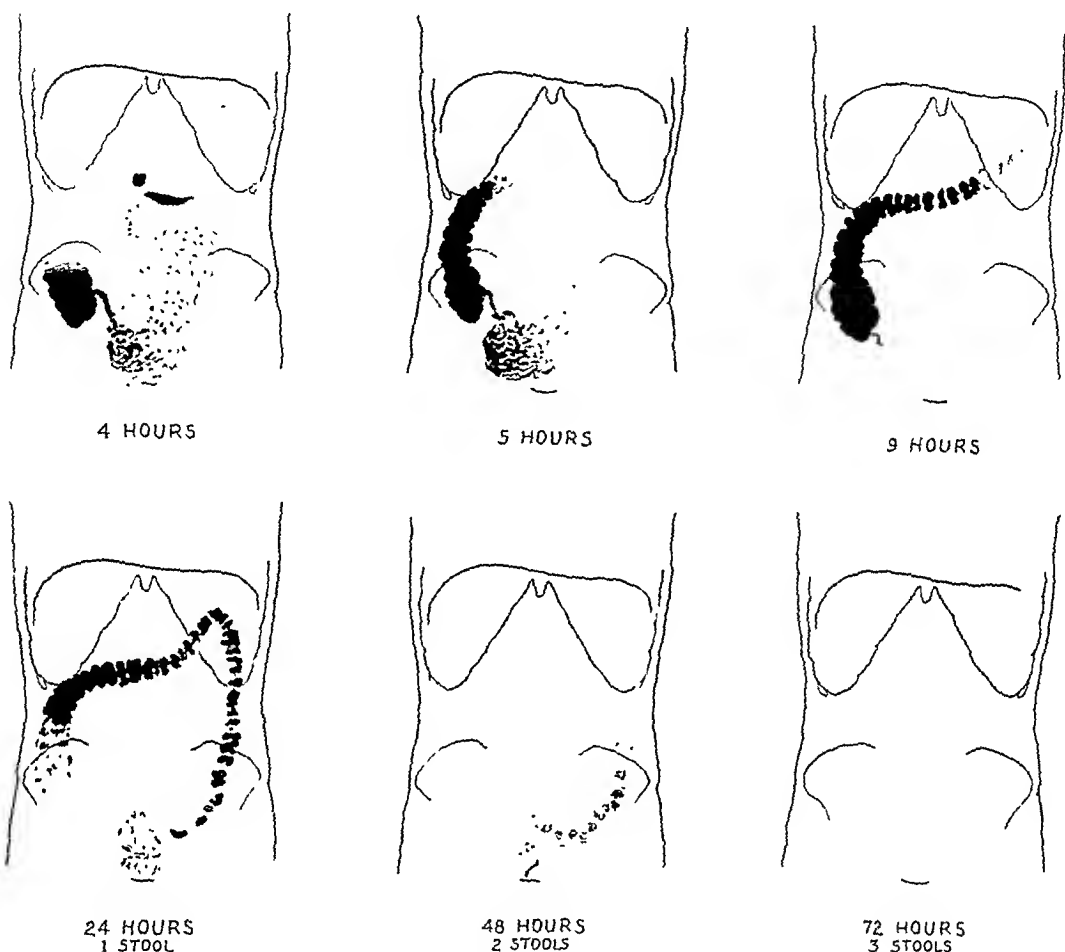


Fig. 1. Normal colonic filling and emptying.

addition of air injection. Chaoul has further refined this method by inventing a balloon belt compressor with which the degree of external pressure can be precisely regulated.

The enema study, and its various refinements, is the prime source of information of colonic form and structure. It is also the best method of studying organic disease, particularly neoplasms. Retrograde obstruction is, of course, well brought out, as is ir-

used in emergencies and for general orientation purposes.

THE NORMAL COLON

A knowledge of normal roentgen anatomy and physiology is essential. The colon begins at the cecum (*caput coli*), which normally lies in the middle of the right iliac fossa. The entrance of the ileum into the colon (ileocecal valve) marks the junction of the cecum and the ascending colon. Im-



Fig. 2. Carcinoma of the cecum (operative control). Filling defect, shown by ordinary opaque enema. Same case as shown in Figure 3.



Fig. 3. Carcinoma of the cecum. Actual growth, visualized by double contrast enema. Same case as shown in Figure 2.



Fig. 4. Extra-colonic lymphosarcoma (operative control). Pseudo-filling defect of the cecum, shown by ordinary opaque enema. Same case as shown in Figure 5.



Fig. 5. Extra-colonic lymphosarcoma. Integrity of the cecum established by double contrast enema. Same case as shown in Figure 4.

circumstances, simple fluoroscopy without preparation may suffice to establish the site of the trouble. The bowel proximal to the point of stoppage is usually distended with gas, whereas, distal to this region, no shadow is visible. A "flat plate" should be made for more deliberate study. If time and the condition of the patient warrant, an opaque enema may be administered to confirm the findings, as well as to demonstrate a possible filling defect, should a neoplasm be present. Palpation during fluoroscopy helps to determine the relations of tenderness, bowel wall rigidity, and tumefaction in the obstructed area.

In incomplete occlusions a small barium meal may be administered to bring out the degree of obstruction or its effect on the proximal colon in the way of hypertrophy (increased peristalsis) and dilatation. It has been observed that the most distal point reached by the barium column may still fall short, by several inches or even a foot, of the actual location of the blockage. This phenomenon is explained by the presence of spasm or of non-opaque feces, in the region immediately proximal to the obstruction. Objection may be raised to the use of barium meals in any case in which obstruction is suspected. Although the danger associated with precipitating a complete stoppage is not so great in the colon as in the small gut, it is best to restrict the use of this method to cases in which adequate surgical skill is immediately available.

Tumors.—The filling defect, which is the characteristic manifestation in tumors of the colon, may be revealed by both opaque meal and opaque enema. The latter method is preferable, not only because of the dangers associated with obstruction, but because the filling of the colon is much more complete and more easily controlled when it is performed from below. In administering the clyisma, an effort should be made to have some of the injection pass proximal to the

neoplasm so that the full extent and configuration of the tumor may be visualized. When this effort fails with the opaque fluid alone, the double contrast enema, or the compression method, may succeed in producing some beautiful demonstrations. By means of the compression method, Berg has successfully studied the mucosal outline in tumors. In the contrast enema technic, the tumor mass itself is directly visualized much in the manner of a cancer of the fornix projecting into the stomach bubble (Figs. 2 and 3).

Sometimes it is difficult to decide whether a suspicious area is the site of a true filling defect or a severe spasm. In such cases, it is advantageous to repeat the examination, following the administration of belladonna to physiologic tolerance, or, as recently recommended by Holmes, during the inhalation of a few pearls of amyl nitrite.

When the tumor is not essentially obstructive, as in the case of a growth originating in the mucosa, but is spreading chiefly through the deeper layers, or on the peritoneal surface, the presence of a neoplasm may be overlooked entirely by methods now at our disposal. Until recently a similar failure frequently attended the demonstration of small polypoid masses. These were often entirely overshadowed by the mere bulk of the opaque injection. It is in just such cases that the new double contrast enema, to which Fischer and Weber have made noteworthy contributions, has proved so useful. It is possible that the contrast enema will help still further to distinguish between deformities in colonic outline due to intrinsic and extrinsic causes. I have recently found it of great help in deciding whether a large tumor was intra- or extra-cecal in location (Figs. 4 and 5).

Colitis Gravis.—In so-called idiopathic or ulcerative colitis, especially in the advanced stage, the bowel changes are well recorded



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studied, but not very extensively (Vallarino, Henderson). The cecocolon is most commonly involved. Irregularities in outline may be present but Henderson believes that this segment is much less irritable in amebic colitis than in tuberculosis.

Appendicitis.—In acute and perhaps in recurrent subacute appendicitis the diagnosis should be made clinically; the X-ray is really not needed.

Chronic appendicitis is a much disputed disease, the very existence of which is doubted by many competent observers. The roentgen criteria that have chiefly been used in diagnosing it are fixation and tenderness of the appendix vermiformis. However, these findings lose their special significance when it is realized that fixation may be due to congenital pericecal bands or membranes, and that tenderness may likewise be explained by causes other than inflammation, such as sensitiveness of the neighboring nerve plexuses. In a series of 286 individuals whose appendix had been removed, right lower quadrant tenderness persisted in 31 per cent, an incidence one and one-half times greater than that found in an unselected series of 1,639 cases in which right lower quadrant tenderness occurred in 320 cases, or 19 per cent. The clinical significance of barium stasis in the appendix is still questionable. Our experience is that appendiceal stasis is closely associated with cecal stasis. However, we were unable to find any causal relation between cecal stasis and appendiceal disease (Kantor, Schechter, and Marks).

The above data all point to the wisdom of making the diagnosis of chronic appendicitis circumspectly and only after all other causes for right lower quadrant symptomatology have been excluded. Indeed we have come to the conclusion that perhaps the chief value of the X-ray here lies in the correct appraisal of other possible sources of local-

ized symptoms, such as low cecum, right-sided colitis, cecal stasis, calcified mesenteric glands, and ureteral stone. Tubo-ovarian disease and simple hernia are additional factors to be considered in the presence of right lower quadrant complaints, though they are not susceptible of roentgen demonstration.

RARE DISEASES AND CONDITIONS

Actinomyces.—This disease resembles tuberculosis in its tendency to localize in the cecum, but differs from it by involving the outer walls of the bowel, rather than the mucosa. This characteristic naturally makes the roentgen diagnosis of actinomyces a matter of difficulty. However, the tendency to fistula formation should be borne in mind as it may aid in the recognition of this disease.

Fistulae.—These may be demonstrated either by enema or by the injection of an opaque substance from without. Perhaps the most common internal fistulae are produced by carcinoma, whether it originates in the colon itself or in some adjacent viscus.

Non-specific Granuloma.—A rare form of non-specific hyperplastic inflammation of the colon may be suspected from the filling defect occasionally produced (Bargen, Goldfarb, and Sussman). However, a positive pathologic diagnosis is naturally beyond the reach of our present roentgen methods.

Morphine Hunger.—Ludlum and McDonald have studied the colon in morphine hunger.

Foreign Bodies.—If the foreign body is radiopaque, recognition is relatively easy, depending on its size and location. Foreign bodies originating within the alimentary tract, such as gallstones and fecaliths, are of special interest. These may be revealed even without the aid of an opaque substance. In some cases, the injection of air alone, or the use of a double contrast enema, is helpful

by the opaque enema method. The affected portions of the colon are extremely irritable. There is a slight delay in filling and a great deal of haste in emptying. The colon is contracted either by spasm or by an actual shrinkage of the lumen, due to wall thickening and stricture formation. Often pockets of gas are caught between the spastic areas. The appearance of the diseased bowel has been likened to a tape or band, and, when spasm predominates, to a string of sausages. In the stage of pseudo-polypoid, a characteristic mottled appearance is presented by the barium column, the negative shadows representing the islets of intact mucosa between the deep and confluent ulcerations.

Although the barium meal changes are similar in character to those of simple colitis, they are far more severe in degree. There is much streaking, feathering, loss and distortion of haustrations, and disruption of the fecal column. Mass peristalsis is commonly observed in these cases.

Tuberculosis.—For the diagnosis of tuberculosis both the opaque meal and the opaque enema are useful. The meal reveals irritability and deformity in the proximal colon, which is the region (next to the terminal ileum) most commonly affected by the Koch bacillus. The most important single observation is that made nine hours after the administration of the barium. In a typical case of ulcerative cecal or cecocolic tuberculosis, the classic Stierlin phenomenon may be present. There is delayed emptying of the ileum, non-filling of the involved proximal colon, and rapid filling of the colon distal to the lesion. Not uncommonly the head of the barium column has reached the rectum, or one or more barium stools have been passed by this time.

The Stierlin phenomenon is not pathognomonic of tuberculosis of the cecocolon. It may be observed in tuberculous ulceration of the ileum in the presence of an intact

colon, as well as in other diseases of the cecum or its neighborhood, such as amebic or ulcerative colitis, carcinoma, or even appendix abscess. Conversely the Stierlin phenomenon may be absent in proven cecal tuberculosis. Here the cecocolon may appear either quite normal in outline or else it may fill irregularly, with loss of typical contour and haustral configuration.

In hyperplastic tuberculosis, the contracted cecocolon appears as a narrow, centrally placed, fistulous tract outlined either by barium alone or by a mixture of barium and the intestinal gas so commonly present in this condition. A hard elongated tumor may be palpated in the involved area.

Examination of the tuberculous colon by the opaque enema reveals localized deformity, irritability, and spasm in the proximal colon. The simultaneous appearance of a filling defect in the cecum and of entry of barium into the terminal ileum, due to ileocecal insufficiency, constitutes, as Gershon-Cohen points out, an analogue of the Stierlin phenomenon. Fleischner and Gershon-Cohen have emphasized the advantages of the double contrast enema in the study of colonic tuberculosis. Deformities of the ileocecal valve and actual ulcerations of the mucous membrane may be brought to light by this method. In addition, a hyperplastic inflammation of the mucosa may be suspected from a mosaic appearance of the barium shadows, which is in marked contrast to the uniform coating in the unaffected distal colon.

Other Ulcerative Processes.—In dysenteries of other origins, the roentgen ray alone is at present unlikely to make a positive etiologic diagnosis. The early stages of all the organic colitides may be indistinguishable from simple colitis (*quod vide*). Advanced cases may show findings similar to those described in colitis gravis or tuberculosis, according to the specific localization of the condition. *Amebic colitis* has been

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Foreign Bodies.—If the foreign body is radiopaque, recognition is relatively easy, depending on its size and location. Foreign bodies originating within the alimentary tract, such as gallstones and fecaliths, are of special interest. These may be revealed even without the aid of an opaque substance. In some cases, the injection of air alone, or the use of a double contrast enema, is helpful

by the opaque enema method. The affected portions of the colon are extremely irritable. There is a slight delay in filling and a great deal of haste in emptying. The colon is contracted either by spasm or by an actual shrinkage of the lumen, due to wall thickening and stricture formation. Often pockets of gas are caught between the spastic areas. The appearance of the diseased bowel has been likened to a tape or band, and, when spasm predominates, to a string of sausages. In the stage of pseudo-polypoid, a characteristic mottled appearance is presented by the barium column, the negative shadows representing the islets of intact mucosa between the deep and confluent ulcerations.

Although the barium meal changes are similar in character to those of simple colitis, they are far more severe in degree. There is much streaking, feathering, loss and distortion of haustrations, and disruption of the fecal column. Mass peristalsis is commonly observed in these cases.

Tuberculosis.—For the diagnosis of tuberculosis both the opaque meal and the opaque enema are useful. The meal reveals irritability and deformity in the proximal colon, which is the region (next to the terminal ileum) most commonly affected by the Koch bacillus. The most important single observation is that made nine hours after the administration of the barium. In a typical case of ulcerative cecal or cecocolic tuberculosis, the classic Stierlin phenomenon may be present. There is delayed emptying of the ileum, non-filling of the involved proximal colon, and rapid filling of the colon distal to the lesion. Not uncommonly the head of the barium column has reached the rectum, or one or more barium stools have been passed by this time.

The Stierlin phenomenon is not pathognomonic of tuberculosis of the cecocolon. It may be observed in tuberculous ulceration of the ileum in the presence of an intact

colon, as well as in other diseases of the cecum or its neighborhood, such as amebic or ulcerative colitis, carcinoma, or even appendix abscess. Conversely the Stierlin phenomenon may be absent in proven cecal tuberculosis. Here the cecocolon may appear either quite normal in outline or else it may fill irregularly, with loss of typical contour and haustral configuration.

In hyperplastic tuberculosis, the contracted cecocolon appears as a narrow, centrally placed, fistulous tract outlined either by barium alone or by a mixture of barium and the intestinal gas so commonly present in this condition. A hard elongated tumor may be palpated in the involved area.

Examination of the tuberculous colon by the opaque enema reveals localized deformity, irritability, and spasm in the proximal colon. The simultaneous appearance of a filling defect in the cecum and of entry of barium into the terminal ileum, due to ileocecal insufficiency, constitutes, as Gershon-Cohen points out, an analogue of the Stierlin phenomenon. Fleischner and Gershon-Cohen have emphasized the advantages of the double contrast enema in the study of colonic tuberculosis. Deformities of the ileocecal valve and actual ulcerations of the mucous membrane may be brought to light by this method. In addition, a hyperplastic inflammation of the mucosa may be suspected from a mosaic appearance of the barium shadows, which is in marked contrast to the uniform coating in the unaffected distal colon.

Other Ulcerative Processes.—In dysenteries of other origins, the roentgen ray alone is at present unlikely to make a positive etiologic diagnosis. The early stages of all the organic colitides may be indistinguishable from simple colitis (*quod vide*). Advanced cases may show findings similar to those described in colitis gravis or tuberculosis, according to the specific localization of the condition. *Amebic colitis* has been

studied, but not very extensively (Vallarino, Henderson). The cecocolon is most commonly involved. Irregularities in outline may be present but Henderson believes that this segment is much less irritable in amebic colitis than in tuberculosis.

Appendicitis.—In acute and perhaps in recurrent subacute appendicitis the diagnosis should be made clinically; the X-ray is really not needed.

Chronic appendicitis is a much disputed disease, the very existence of which is doubted by many competent observers. The roentgen criteria that have chiefly been used in diagnosing it are fixation and tenderness of the appendix vermiformis. However, these findings lose their special significance when it is realized that fixation may be due to congenital pericecal bands or membranes, and that tenderness may likewise be explained by causes other than inflammation, such as sensitiveness of the neighboring nerve plexuses. In a series of 286 individuals whose appendix had been removed, right lower quadrant tenderness persisted in 31 per cent, an incidence one and one-half times greater than that found in an unselected series of 1,639 cases in which right lower quadrant tenderness occurred in 320 cases, or 19 per cent. The clinical significance of barium stasis in the appendix is still questionable. Our experience is that appendiceal stasis is closely associated with cecal stasis. However, we were unable to find any causal relation between cecal stasis and appendiceal disease (Kantor, Schechter, and Marks).

The above data all point to the wisdom of making the diagnosis of chronic appendicitis circumspectly and only after all other causes for right lower quadrant symptomatology have been excluded. Indeed we have come to the conclusion that perhaps the chief value of the X-ray here lies in the correct appraisal of other possible sources of local-

ized symptoms, such as low cecum, right-sided colitis, cecal stasis, calcified mesenteric glands, and ureteral stone. Tubo-ovarian disease and simple hernia are additional factors to be considered in the presence of right lower quadrant complaints, though they are not susceptible of roentgen demonstration.

RARE DISEASES AND CONDITIONS

Actinomycosis.—This disease resembles tuberculosis in its tendency to localize in the cecum, but differs from it by involving the outer walls of the bowel, rather than the mucosa. This characteristic naturally makes the roentgen diagnosis of actinomycosis a matter of difficulty. However, the tendency to fistula formation should be borne in mind as it may aid in the recognition of this disease.

Fistula.—These may be demonstrated either by enema or by the injection of an opaque substance from without. Perhaps the most common internal fistulæ are produced by carcinoma, whether it originates in the colon itself or in some adjacent viscus.

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for the demonstration. A Bucky diaphragm is usually required for this work.

FUNCTIONAL DISORDERS

Constipation.—The diagnosis of constipation cannot always be made on the history alone. This point was investigated in 844 cases in which the emptying of the colon after the administration of an opaque meal was studied in detail. Agreement between the history and the roentgen findings was noted in only 68 per cent of the cases. In the remaining 32 per cent, the discrepancy took place in either direction; that is, in 20 per cent, the patient was constipated according to the history and not according to the roentgenograms, and in 12 per cent, the finding was reversed. It would thus appear that more people think they are constipated when they are not than the other way around.

Since the normal total colon emptying time was found to lie between 48 and 72 hours after the administration of the meal, constipation in the general sense may be diagnosed if barium is visible in either colon or rectum at the 72-hour observation. The sub-variety of constipation known as dyschesia (rectal stasis) may be diagnosed even earlier, usually at 48 hours. In order to complete the diagnosis, it is wise for the observer to satisfy himself by rectal palpation that the rectal shadow represents a true impaction, *i.e.*, that it is of such size and density that the patient cannot be expected to relieve himself spontaneously or without damage to his anal mucosa.

The cause of most of the varieties of constipation lies in the distal colon. Here the X-ray examination readily demonstrates the increased spasticity, the redundancies, and the kinks that may be at fault. For the demonstration of anatomic abnormalities (see below) the enema is the method of choice. Redundancy is found in 22 per cent

of constipation cases, or one and one-half times its general incidence. The significance of kinks of the pelvic colon, particularly if this part of the bowel is prolapsed and adherent, has been emphasized by Case.

Nearly one-fifth of all patients show a tendency to rectal impaction. Soper has come to the conclusion that an obstinate form of rectal stasis is intimately associated with absence of a normal rectosigmoid apparatus.

Proximal colon stasis is of relatively little clinical importance unless it is associated with distal colon (ordinary) constipation and a low cecum. Owing to the complicated way in which retention may occur in this region, several subvarieties of proximal colon stasis have been described. In general, stasis may be diagnosed when barium is present in the cecum or cecocolon for 48 hours or more after the barium meal.

The Irritable Colon.—This condition, also called simple colitis, is revealed by characteristic alterations in the appearance and function of the colon. Hypermotility, probably the most important feature, is best demonstrated by the opaque meal. Irritable colon is said to be present when the head of the barium column has passed the splenic flexure at the five-hour observation, or reached the rectum with or without the passage of a barium stool at nine hours, or when the colon is entirely empty at 24 hours. Ileal stasis may be associated with the colonic hypermotility at the nine-hour observation. The haustra may be irregular, deformed, unbalanced, or entirely absent. In addition, the barium column may present a characteristic mottled, feathered, or stringy appearance. The latter is especially suggestive of mucus. In some cases the colon filling is quite interrupted, in others it may be marked by an excess of gas. These changes do not necessarily involve the whole extent of the large intestine, nor are they constant in appearance. It will be noted

that most of the significant roentgen criteria of colitis are available at the nine-hour observation, hence the importance of this test as a short-cut to diagnosis.

The opaque enema is also of value in the diagnosis of colonic irritability. Perhaps the chief feature brought out by this method is the diminished capacity of the colon. It can be directly measured in terms of ounces required to fill to the cecum, the normal being 38, as well as by the increased rapidity of inflow, the narrowed caliber, the unusual ironing-out of the haustra, and the increased pain during the administration of the clysm. In some cases, fine serrations may be superimposed on the normal haustral outlines. This so-called fibrillation (Mills) is especially likely to occur in early stages of diverticulosis (see below).

ANOMALIES

Anomalies of Length.—The redundant colon. The enema best reveals the bowel topography, but the progress meal is needed for a complete diagnosis of the pathologic physiology. The roentgen criteria of the redundant colon are:

In the typical case, the elongated pelvic loop must rise completely out of the false pelvis, *i.e.*, above the interiliac crest level seen in the prone film taken after the opaque enema. In the sub-variety known as "pelvic loop to the right," a portion of the elongated pelvic colon must lie in the right iliac fossa. Of course, redundancies of lesser magnitude may at times be clinically significant, but the rules just stated have been found most satisfactory for the classification and study of our own material. It is interesting to note that the average amount of enema fluid needed to fill this type of colon is 46 ounces, as compared with the normal 38 ounces. As much as 128 ounces was required in one of our cases. Associated displacement and distortion of the stomach from gas in the

splenic flexure are not uncommon and are worth recording.

Anomalies of Rotation.—In non-rotation of the colon, the cecum is located in the left iliac fossa, the ileum enters from the right side, and the ascending colon may fail entirely to cross to the right of the midline. The splenic flexure and the distal colon in general remain in the normal position. This leaves the small intestine to fill the right half of the abdomen.

Anomalies of Descent.—Hyperdescent (low cecum) and hypodescent (high cecum) are both best visualized at the nine-hour observation. The opaque enema may be used for the demonstration of high cecum, but it is not so helpful in the case of low cecum, owing to the number of shadows superimposed in the pelvis.

The roentgen criteria of cecal descent are:

The normal cecum comes to rest in the middle of the right iliac fossa. The low cecum reaches, or passes below, the level of a line joining the tops of the acetabular cavities as seen in the standard prone film. This implies that the caput coli passes at least half-way down into the true pelvis. Only prone observations are employed in making these measurements.

In complete non-descent, the cecum remains in the sub-hepatic position or, at any rate, does not pass below the level of the right iliac crest. However, since such cases are rare, it may be permissible, for certain study purposes, to diagnose a condition of "high cecum" when the tip of the cecum does not pass below the upper third of the ilium, measuring from the crest to the top of the acetabular cavity.

It is well to recall that occasionally the proximal transverse colon hangs down, festoon-like, in such fashion as to resemble a normal ascending segment, and covers the high-placed inverted cecal tip, which may even be attached to the liver. The true rela-

tions are visualized, as Jordan has pointed out, by radiography in the right oblique position.

Anomalies of Fixation.—These anomalies apply only to the right, or cecocolon. They are best studied at the nine-hour observation, when both prone and erect films are made. The crest of the ilium should always be centered at the middle of the film in order to insure comparable readings. The degree of mobility of the hepatic flexure and of the cecum may be separately estimated. A preliminary review of 259 cases showed an average hepatic flexure mobility of 1.76 inches and an average cecal mobility of 1.4 inch. The standards for normal, hyper-, and hypomobility of the right colon are now being studied.

Megacolon.—This anomaly is readily diagnosed by the opaque enema. Instead of filling to the cecum with the normal 38 ounces, the affected loop alone may hold much more than this amount (104 ounces in one instance). The differential diagnosis between Hirschsprung's disease and redundant colon is not difficult to make. In the former, the involved loop is tremendously dilated; in the latter, the loops are elongated with very little, if any, dilatation.

Diverticulosis.—Diverticulosis is here classed as an anomaly because predisposition to this condition seems to exist from birth. The diagnosis is made by both roentgen methods, which readily reveal the sacculations. The peripheral location of the circular shadows is characteristic. Spriggs and Marxer have described a saw-tooth appearance of the pelvic colon (also called serration, or fibrillation) as a prediverticular finding. Case emphasizes the associated displacement of the small intestine upward and to the right, especially if diverticulitis thickens the affected iliac and pelvic colon. It should be borne in mind that diverticula lend themselves admirably to demonstration by the

double contrast enema and the mucosal relief methods.

When diverticulitis is superimposed on the underlying diverticulosis, spasm often occurs so severe as to cause more or less of a filling defect of the involved segment. In this case, especially if tumefaction is present, a differentiation from carcinoma may be very difficult. The use of antispasmodics, as recommended in the discussion of tumors, is indicated under such circumstances.

SUMMARY

1. The roentgen study of the colon is described. A technic suitable for the average private patient is presented in some detail.
2. Standards for normal colon function are given.
3. The special diagnosis of the most important organic diseases, functional disorders, and anomalies is presented.

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DISCUSSION

DR. L. R. SANTE (St. Louis): Dr. Kantor's excellent work with the large bowel is familiar to all radiologists. The clue to his success was given in his first few paragraphs in which he designated and outlined the precision with which he goes about the examination. While his paper was so all-inclusive that it defies detailed discussion, it leaves one impression with us, namely, that it is deplorable in this day and age for the examination of the gastro-intestinal tract to be looked upon very much the same as other laboratory procedures, rather than as an intricate clinical study.

Every radiologist has been outwitted by an examination of the colon. Every man of any great experience has missed small lesions on one side or the other of the gut that were overshadowed by the bulk of the barium mixture. However, if we go about the examination of the colon with the care and precision that Dr. Kantor has outlined, our work will be much more precise and satisfactory.

ROENTGEN FINDINGS IN ALLERGIC INDIVIDUALS¹

By C. H. HEACOCK, M.D., The Polyclinic, MEMPHIS, TENNESSEE

DURING the past three and one-half years roentgenologic examinations have been made of 368 allergic patients, selected from a group of 1,200, in the Department of Hay Fever and Asthma at The Polyclinic. The diagnoses, made by Dr. John P. Henry, were based on the histories, physical findings, and positive reactions to allergens applied by one or more of the methods of skin testing.

The number of examinations of the various regions was as follows:

Chest alone	51
Chest and sinuses	190
Sinuses alone	109
Gastro-intestinal tract.....	49
Colon alone	3
Miscellaneous	10

The final diagnoses, representing all the forms of allergy, are given in the tabulation below:

Asthma	119
Hay fever	103
Asthma and hay fever.....	94
Gastro-intestinal allergy.....	37
Others (mostly cutaneous forms).....	15

Henry (4) points out certain facts which will aid us in an understanding of allergic conditions:

(a) Hay fever, asthma, certain dermatoses, and certain affections of the mucous membranes of the gastro-intestinal tract are similar in nature, differing only in the kind and location of the cells involved.

(b) The symptoms are the result of an altered reactivity of these cells.

(c) This altered reactivity is due to a sensitization of the cells to substances which are harmless to normal persons.

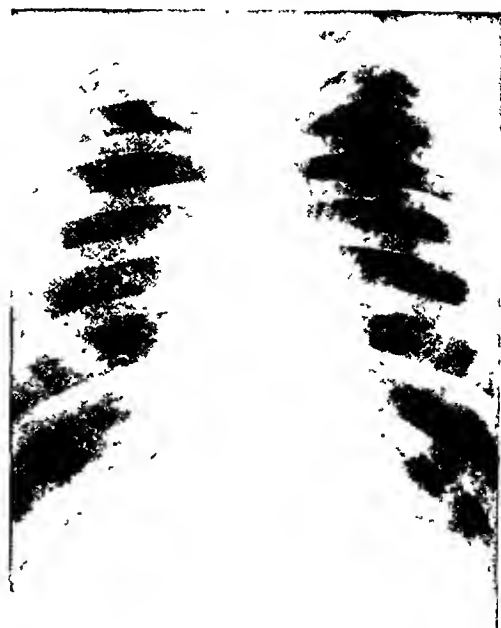


Fig 1. Changes in the hila and peritruncal shadows in a patient with asthma and hay fever. The sinuses were not involved

(d) Although the actual sensitization is acquired, the ability to become sensitive is, in the majority of cases, an hereditary characteristic.

Allergic symptoms may appear at any age. The oldest patient in this series was 73 years of age and the youngest was two weeks of age.

Sensitization is confined chiefly to mucous membranes, but the variations from normal are seldom visible roentgenologically except in the nasal accessory sinuses and bronchi. The changes in the bronchi are slight unless the allergy manifests itself as asthma. Of 40 patients with no asthmatic symptoms, inconspicuous changes were seen in the chest roentgenograms of 5; the remainder were entirely negative.

¹Read before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov 30-Dec 4, 1931

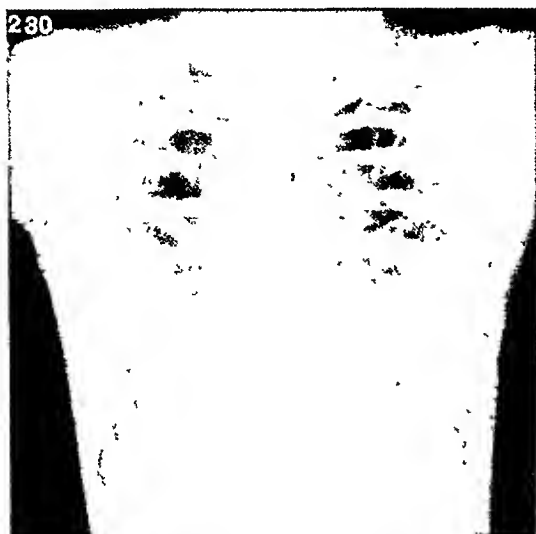


Fig 2. Changes similar to those in Figure 1. Sinuses also were involved in this 11-year-old boy, who had suffered from asthma and hay fever for eight years.

CHEST

According to the classification of Manges (5), the variations from normal in 241 chest examinations of our series were as follows:

Peritruncal thickening	55
Chronic lower lobe infection.....	17
Hilar changes alone.....	54
Tuberculosis	29
No changes	86

It is difficult to determine whether allergy or infection is responsible for peritruncal thickening, chronic lower lobe infection, and changes in the hila. The pathologic processes in asthma are not clearly defined in the minds of pathologists themselves. Only a few necropsies have been performed. Steinberg and Figley (9) had the opportunity to make postmortem examinations in two cases of asthma. They distinguished between non-bacterial allergic asthma and bacterial asthma. In the non-bacterial type they found emphysema, partial or complete occlusion of the bronchioles with mucus, marked hypertrophy of the bronchial musculature, cellular exudation into both the lumen and walls of the bronchi, and hyperactivity of the

glands. These changes, of themselves, are capable of producing all the exaggeration of the normal shadows usually seen in the roentgenograms of asthmatic patients. It can readily be understood why infection sooner or later may be superimposed upon such an altered membrane, followed by signs of chronic lower lobe infection, purulent bronchitis, and even bronchiectasis or bronchopneumonia. Four patients in this group presented the roentgenologic picture of bronchiectasis. The increase in size and density of the hilar shadows, either alone or accompanied by an increased width and density of the peritruncal shadows, was found consistently in all the patients with asthma, especially when the disease had persisted over several years. It is readily admitted that the roentgen appearance of the lungs in asthma is not pathognomonic. It cannot be distinguished from non-allergic bronchitis, sinus-bronchial disease, some forms of juvenile tuberculosis, changes due to influenza or excessive smoking, or passive congestion.

Sinus-bronchial disease is especially interesting in this connection, as it has been claimed that sinus infection is the cause of asthma. Although co-existent sinus disease may contribute to bronchial variations in asthma at times, it is not the prime factor. Sinus examinations of 21 of our patients were negative, yet definite hilar and peritruncal changes were present. The majority of the adults had undergone some type of sinus operation without relief, but had responded to specific allergic treatment. In these, however, too few follow-up examinations with the roentgen ray have been made to justify any conclusions regarding the disappearance of shadows. After studying 1,074 patients with asthma to determine the part played by focal infection, Rackemann and Toby (8) found that drainage of infected sinuses or removal of nasal polypi gave temporary relief in a large number of

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or asthma cannot be cured until the sinuses are treated. On the other hand, it is the opinion of allergists that infection in the sinuses is secondary, and that allergic treatment should always precede surgery. As

nuses were radiographed in 299. Some variation from the normal was found in 214, or 71.6 per cent. The following tabulation shows to what extent the sinuses were affected

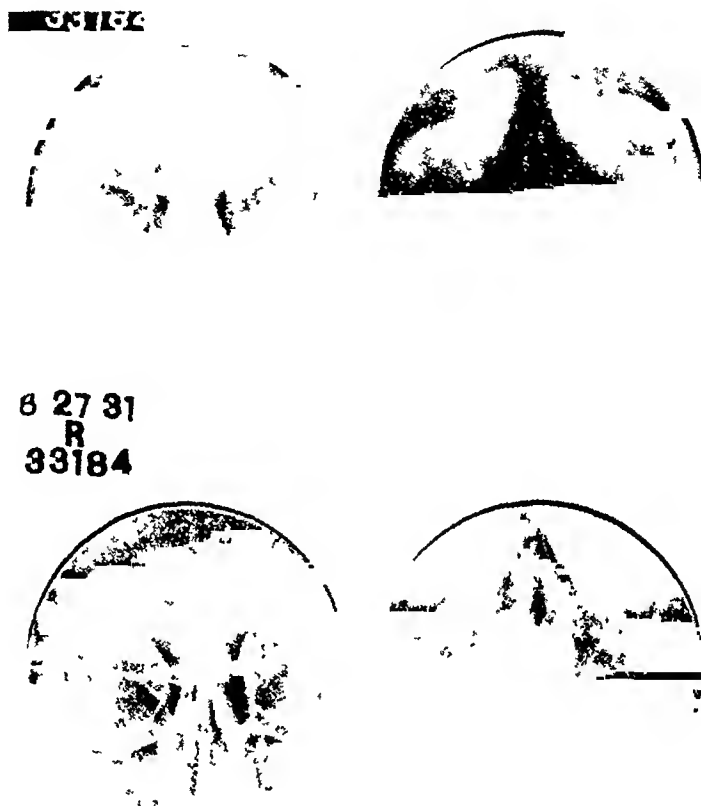


Fig 3-C Sinuses of the patient whose chest is shown in Figures 3-A and 3-B. The sinuses never received local treatment. Two years between examinations.

roentgenologists, we need not take sides in this controversy. We are in a position to render assistance to both rhinologists and allergists in determining whether the sinuses are involved, how many cells are affected, and, in a number of cases, the nature of the pathologic changes. Our method of examination offers a means of accurately checking the results, whatever the treatment employed.

Of the 368 patients in this group, the si-

Patients with changes in only one sinus	48
Patients with changes in two sinuses....	68
Patients with changes in two or more, but not all	65
Patients with changes in all.....	33
Patients with changes in none.....	85
Total	299

The antra alone were affected in 85 patients, the largest number in which only one



Fig 3-A Typical changes in hilar and lower lobes of 17-year-old boy who had had asthma for ten years. The interlobar pleurisy on the right and the upper lobe changes are interpreted as tuberculosis.

Fig 3-B Same case as shown in Figure 2-A. Marked improvement after two years specific allergic treatment. Symptomatically well.

cases, but asthma was permanently eliminated in only 5 per cent.

Manges (5) has seen complete collapse of a lobe from occlusion of a bronchus in asthma. We have had no similar case, although one of our patients presented a small area of consolidation, unaccompanied by any of the signs or symptoms of pneumonia or abscess. The condition, which cleared up completely in a short time, was believed to be due to a small area of atelectasis secondary to occlusion.

One of the present cases was of special interest because of a transitory cellular emphysema. Asthma is often characterized by emphysema of the lungs, but in this case the route taken by the air to reach the tissues over the chest was open to conjecture. The case is being reported in detail by Dr. John P. Henry.

Evidence of pulmonary tuberculosis was found in 29 patients, or 12 per cent. This corresponds closely to the findings of 12 per cent in Manges' series of 354 patients, 18 per cent in Manges and Hawley's (6) group of 157, and 10 per cent in Harkavy and Hebbald's (3) series of 400. From a study of our cases in the Department of Hay Fever and Asthma, we agree with Harkavy and Hebbald that these patients react exactly as do those who are free from tuberculosis and that the tubercle bacillus itself is not responsible for the asthmatic attacks.

SINUSES

In allergic individuals, the mucous membranes of the nose and sinuses are most often affected. The majority of rhinologists believe that infection in the sinuses is the primary etiologic factor and that hay fever

a barium enema. In the majority, a diagnosis of alimentary allergy was made, the offending agents being foods. Since allergy causes none of the organic lesions so readily detected by the roentgenologist, it is not

Carcinoma of the sigmoid.....	1
Duodenal diverticulum.....	1
Tuberculosis of the cecum.....	2

It is interesting to note that one patient had previously had three negative gastro-

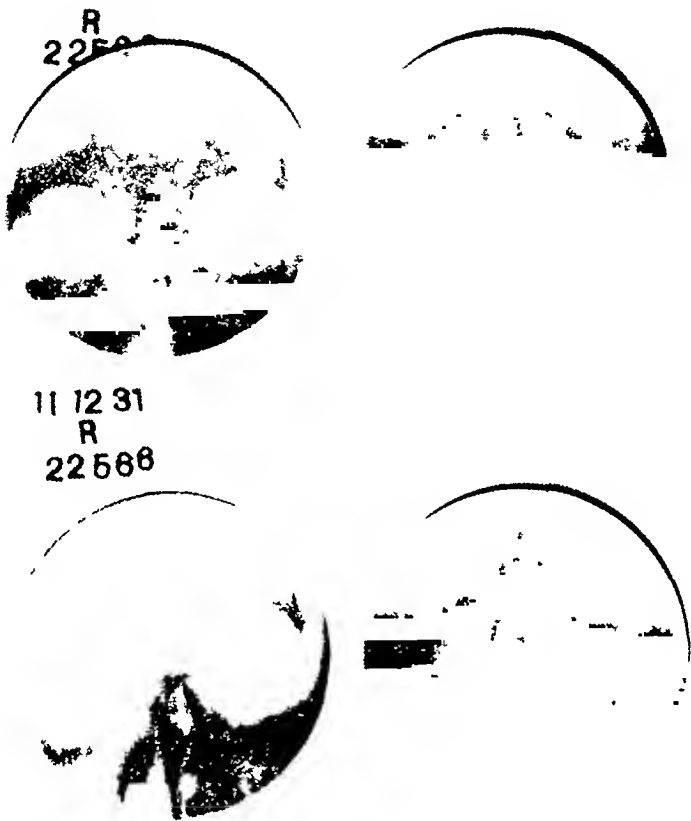


Fig 5 Chronic suppurative pansinusitis superimposed upon an allergic membrane. Antra irrigated once and specific allergic treatment instituted. Complete symptomatic relief but incomplete resolution of the hypertrophied membrane. Fourteen months between examinations.

surprising that 41 of these examinations were entirely negative except for occasional signs of reflex irritation in the stomach and colon. Organic lesions were found in the remaining eight gastro-intestinal cases and in the three in which an examination of the colon was made, as follows:

Duodenal ulcer	4
Gastric ulcer	1
Carcinoma of the stomach.....	1

intestinal examinations at other laboratories. Three patients had been unrelieved by removal of the gall bladder.

Ten of the 49 patients also had tetraiodophenolphthalein orally. The subsequent roentgenograms showed the following:

Gallstones	1
No cholecystogram	3
Normal cholecystogram.....	5
Normal filling but delayed emptying.....	1



Fig 4-A Advanced changes, with lower lobe infection (bronchiectasis), in 13-year-old girl who had suffered from asthma for ten years

Fig 4-B. Same case as Figure 4-A, showing improvement following ten months of allergic treatment. Complete relief of symptoms

set of sinuses was involved. The ethmoids alone were involved in six. In none were the changes limited entirely to the frontals or sphenoids.

Theoretically, allergic conditions are manifested in either of two ways: First, the membrane suddenly becomes edematous and congested, but subsides promptly after several treatments or removal of irritating allergens; or second, the membrane is more or less chronically congested, as in perennial hay fever and asthma. Proetz (7) cites a case which vividly illustrates that the membrane of a single antrum may vary greatly in thickness as the result of only one exposure to feathers. Weille (10) studied 160 specimens of tissue from the sinuses of 26 allergic patients and described the pathologic changes in the second, or chronic type. He found metaplasia of the epithelium and a thickening of the basement membrane. In two-thirds of the cases, edema or fibrosis of the tunica propria was also present. It is his opinion that the thickened membrane offers one chance in nine of harboring pus pockets and of thus becoming a focus of

infection. Hansel (2) made similar investigations with the same result and the additional finding of polypi.

In the roentgenograms of our series of 299, nothing was found which would enable the roentgenologist to identify them immediately as being cases of asthma or hay fever. They presented the changes seen routinely in roentgenograms of pathologic sinuses, regardless of the etiology. The findings are given below, the cloudiness being graded on a basis of 4:

Cloudiness (two or less).....	152
Cloudiness (three or more).....	55
No general cloudiness, but polypi	13
Additional polypi found after lipiodol. ...	3
Generalized hyperplasia after lipiodol....	13

Subsequent roentgenologic examinations were made on but 4 patients following allergic treatment and all were improved.

GASTRO-INTESTINAL TRACT

Forty-nine patients of this series had an examination of the gastro-intestinal tract and in three the colon only was studied with

suddenly swell to ten times its normal thickness when an allergic individual is exposed to the allergen to which he is sensitive. The patient may not be skin-sensitive to this substance, and the skin tests may, therefore, be negative.

2. Some patients are sensitive to radiopaque oils or their components, and a swelling of 2 or 3 mm. may occur after the oils have remained in their sinuses for several hours. An estimation of membrane thickness with radiopaques is, therefore, reliable only in a film made shortly after filling (within an hour).

3. When the membrane is thin and quiescent, comparison of the bone margin shadow with the same shadow after the membrane is swollen indicates little, if any, change in the bone shadow. This leads one to believe that the contrast between bone-to-air surfaces and bone-to-membrane-or-fluid surfaces is not so great as has been supposed. Apparently something more than simply fluid contents is necessary to effect the sharp bone definition, as the bone shadow is quite sharp under the extremely thick sinus mucosa in allergic individuals.

DR. MERL L. PINDELL (Los Angeles, Calif.): Much has been written and said in

regard to certain phases of allergy, but little has been written about chest findings in allergic individuals. Dr. L. W. Dean, in St. Louis, has done some splendid work relating to the sinuses.

I hesitate a little in accepting hila changes in the majority of allergic individuals. The roentgen appearance of the hila, and the territory adjacent to them, is a much disputed subject.

The essayist has shown a few slides of chests that could be considered bronchial pneumonia and tuberculous infiltrates. One slide, in particular, looked a great deal like a tuberculous consolidation in the apex of the middle lobe. I should like to ask Dr. Heacock if a Mantoux test was made on all these children.

DR. HEACOCK (closing): Dr. Proetz's experience has been very much the same as ours. I recognized the lantern slides as being those of the patient with an acute allergic attack, who was referred to in my paper.

The little boy about whom Dr. Pindell inquired did not have a Mantoux test. He had a negative von Pirquet, and there was no clinical suggestion of tuberculosis. No treatment was given for tuberculosis; the beneficial result shown on the film was accomplished entirely by specific allergic treatment.

COMMENT

Balyeat (1) claims that allergic individuals enjoy better than average health. It may be true that they have a stronger resistance to intercurrent infection, but from the study of these 368 patients, the incidence of tuberculosis, peptic ulcer, cancer of the gastro-intestinal tract, and cholecystic disease apparently is as high as in non-allergic persons.

The incidence of sinus affections in 71.6 per cent is certainly higher than is found in the average non-allergic patient. If we consider also those with allergic rhinitis and asthma, the percentage is increased to 78.5. Since it seems reasonable that hay fever and asthma produce a membrane extremely susceptible to bacterial invasion, the percentage of Weille's findings of pus pockets in one case in nine is probably too low. After the membrane has become involved, the signs of exudate, generalized hyperplasia, polypoid hyperplasia, and large localized polypi without general hyperplasia are present in the roentgenogram. We should remember Proetz' warning, however, that one roentgenogram of a thickened membrane does not justify operation, as well as Hansel's advice that non-suppurative or hyperplastic sinusitis should be regarded as an allergic sinus disease until proved otherwise.

Asthma, of itself, by virtue of the consequent thickening of the walls of the bronchioles, produces an exaggeration of the hilar and peritruncal shadows, especially of those in the lower lobes. The picture may be complicated when secondary infection has brought about purulent bronchitis or bronchiectasis. The typical roentgenogram of asthma is one with which we should be familiar, in spite of the fact that it may simulate that of other conditions.

The roentgenologic examination furnishes our most exact method of determin-

ing the extent of allergic processes. As a means of checking results of treatment, its value has not been fully appreciated. It deserves more extensive use.

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DISCUSSION

DR. A. W. PROETZ (St. Louis, Mo.): My discussion must necessarily be from the laryngologist's standpoint. I hope that Dr. Heacock will elaborate that portion of his paper devoted to radiology of the sinuses, and publish it in a laryngologic journal. It is extremely important that the laryngologist should recognize the roentgenographic changes which occur in allergy, otherwise, he will continue to operate upon thickened membranes to the detriment of the patient. Our own observations have emphasized three points to which I wish especially to call your attention:

1. An otherwise normal membrane may

They studied 12 cases, and conclude that the spinal cord is rarely the seat of metastasis from primary carcinoma of the lung, but for both diagnostic and therapeutic reasons, thorough examination and roentgenograms of the chest are advisable in every case in which tumor of the brain is suspected. Of their cases, 11 per cent showed involvement of the central nervous system. Doubrow's⁹ observations in Germany and Czechoslovakia indicate that lung cancers of industrial origin are limited mostly to a few definite mining regions: a similar survey in France did not show the miners there to be affected by the disease. Häbler¹⁰ found from his observations on 47 patients that pulmonary carcinoma is more common in males, but he could not corroborate the assumption that occupational injuries were a possible cause. He could not demonstrate a predisposing influence to coal dust, tobacco smoke, or gas-sing during the War. He does attach importance to the etiologic theories of *abnutzung* (wear and tear) and of carcinoma developing on the basis of congenital epithelial metaplasias. Edwards¹¹ discusses the symptomatology, diagnosis, and examination methods, including thoracotomy for exploration. He mentions 118 cases of primary malignant neoplasm although he cites only five specific ones. He favors X-ray, bronchoscopic, and thoracotomy examinations. For therapy, he prefers radium and X-ray, and feels that radon seeds offer the most encouragement. The degree of result is doubtful in his cases because only a short time has elapsed since the institution of treatment. Fremont-Smith, Lerman, and Rosahn¹² studied 18 cases of primary carcinoma of the lung, and they feel that after the age of fifty, the onset of cough, with pain in the chest, or hemoptysis, should suggest cancer of the lung rather than tuber-

culosis. They stress the point that symptoms of the greatest importance to the patient may be caused by metastases. Cathala and his associates¹³ feel that their case serves as a warning to others to exert great care in interpreting even the most characteristic roentgen shadows. This is prompted by the fact that roentgenologically their case was a typical instance of hydatid cyst, with rupture into the bronchus. The diagnosis of ulcerated cancer was made clinically and confirmed at autopsy.

Tumors of the Pleura.—Of the five cases reported by Klemperer and Rabin,¹⁴ four were giant tumors of the visceral pleura, and one was a diffuse neoplasm of the pleura. The giant tumors are of a low grade of malignancy, progress slowly, and caused death by interference with the circulation.

Thymus Tumors.—Several tumors of the thymus are reported, one of them by Craver,¹⁵ whose knowledge of such conditions is best exemplified in an article in which he stresses the necessity for diagnosis, and the especial value of the roentgenogram. He also notes signs that are often overlooked or misinterpreted, namely, puffiness about the eyelids (in one case a peculiar pink discoloration of the eyelids) and fullness at the base of the neck; swelling of the veins on the chest wall usually in the upper part of the front, at the center, or spreading toward the shoulders; weakness; nervousness; loss of weight; vague pains in the chest; dyspnea; cough; enlargement of the lymph nodes above the clavicles; tumor over or beside the sternum; herpes zoster; abnormal dullness over the sternum; exophthalmos; tachycardia; bronchovesicular breath sounds; partial or complete obstruction of the esophagus. He feels that biopsy is of minor value, and may be dangerous.

⁹Paris méd., March 21, 1931, I, 287.

¹⁰Deutsche Ztschr. f. Chir., May 7, 1931, CCXXXI, 323.

¹¹British Med. Jour., Jan. 24, 1931, I, 129.

¹²New England Jour. Med., Sept. 4, 1930, CCIII, 473.

¹³Bull. et mém. Soc. méd. d. hôp. de Paris, May 25, 1931, XLVII, 818.

¹⁴Arch. Path., March, 1931, XI, 385.

¹⁵Med. Clin. No. Am., September, 1930, XIV, 507.

PROGRESS IN RADIOLOGY DURING 1931: THE THORAX

By W. WALTER WASSON, M.D., DENVER

PART II, BEGINNING WITH TUMORS

TUMORS

THAT carcinoma of the lungs, bronchi, and mediastinum has been on the increase in the past few years seems to be the opinion of most of the writers on the subject. The year 1931 produced several excellent articles in which there appear compilations of personal data and reviews of the literature. There have been correlations concerning the age of incidence and the type of growth, the primary focus and type of spread (direct extension or metastasis), and the primary focus and potential metastases. Also there have been descriptions of symptoms, physical signs, roentgen findings and pathologic appearance, as well as considerations of the etiology and therapy. The general opinion seems to be that although primary carcinoma of the thoracic structures is rare, secondary growths are fairly common; and that the similarity of cancer and other chronic pulmonary diseases is so great that all diagnostic means must be employed to establish a positive diagnosis. As to therapy, combinations of radium, X-ray, and surgery seem most successful, although the prognosis for malignancies of the thorax is highly doubtful.

Primary Carcinoma of the Lungs and Bronchi.—Valuable data on primary carcinoma of the bronchus are compiled by Atkin,¹ who reports necropsies on 93 individuals, from which he draws conclusions as to age, incidence, frequency, metastases, and tendency. In Vinson's² report of 71 cases of primary carcinoma of the bronchus diagnosed by bronchoscopic examination, he expresses the belief that the condition is not a rare one. He obtained beneficial results from radiotherapy. Beutel and Woldrich³

report an interesting case of primary bronchial carcinoma with a secondary anemia. The subject was a worker in the uranium mines of Joachimstal, and the condition was not diagnosed until the third interval examination, and then there was total stenosis of the bronchus. McCrae's⁴ article deals with symptomatology, probable etiology, and treatment of bronchial neoplasms. He concludes that if the mortality from this disease is to be reduced, it must be by education of the profession, exact diagnosis, intelligent and proper therapy (preferably radium and X-ray), and team work. Soulas⁵ advocates bronchoscopic diagnosis of bronchopulmonary cancer to follow and complete clinical and roentgen examinations. Pancoast and Pendergrass⁶ report a new technic for radiation therapy of primary bronchogenic carcinoma of the lungs. They employ weak radon tubes (not over 1.5 mc.), and implant them in the growth under bronchoscopic guidance. The treatment seems advisable in growths of bronchogenic origin, preferably pedunculated, and those that have not invaded the bronchial wall to a great extent. Menne, Bisailon, and Robertson⁷ conclude from their pathologic and clinical study of 16 cases of primary bronchogenic cancer that there are two groups, hilar nodular and diffuse necrotic, and that "further pathologic classification is superfluous and unnecessary." They feel that symptoms, signs, and findings can be explained on the basis of pathologic changes. Davison and Horwitz⁸ were interested in metastases from primary lung cancer to the central nervous system.

¹Arch. Otolaryngol., December, 1930, XII, 727.

²Bull. et mém. Soc. méd. d'hôp. de Paris, Nov. 2, 1931, XLVII, 1536.

³Am. Jour. Roentgenol. and Rad. Ther., March, 1932, XXVII, 357.

⁴Northwest Med., April, 1931, XXX, 155.

⁵Arch. Int. Med., October, 1930, 680.

¹Jour. Path. and Bact., May, 1931, XXXIV, 343.

²Minnesota Med., January, 1932, XV, 15.

³Ztschr. f. Krebsforsch., Aug. 14, 1931, XXXIV, 109.

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¹⁵Med. Clin. No. Am., September, 1930, XIV, 507.

The therapy is always irradiation. Metastases under strange guises are to be watched for.

Primary Carcinoma of the Trachea.—Figi's¹⁶ report of five cases of primary carcinoma of the trachea, with the results of therapy, seems to be the only one on the subject. One of his cases had remained well over a year after treatment; the rest had died. He says the condition is one that is seldom recognized early, although there is a definite syndrome produced, namely, slight irritation or tickling sensation in the trachea especially on lying down, paroxysms of coughing with production of crusts or clots of blood, active hemorrhage, or persistent hoarseness, increasing dyspnea or stridor. Therapeutically, he advises destruction with surgical diathermy followed by exposure by tracheotomy, and then irradiation. Only those moderate early lesions which are situated in the upper half of the trachea offer possibility of cure. He believes that roentgenographic, bronchoscopic, and clinical examinations all aid in the diagnosis, but that biopsy must be used advisedly as it may prove dangerous.

Secondary Growths.—Among the reports of secondary pulmonary growths is the very valuable study by Kirklin and Ochsner¹⁷ concerning roentgenographic observations of 206 proved cases of malignancy. The greatest incidence was from cancer of the breast. There was no involvement in one-eighth of these cases, but when it did occur, it was usually bilateral. If unilateral, the right side was the one more frequently involved. In more than one-third, accompanying pleuritic exudate was present; there was increased hilar infiltration in 39 per cent, and the frequency of the infiltrative lesions was almost as great as that of discrete nodules. The distinctive feature was pleural involvement. Malignant testicular tumors pro-

duced definite circumscribed pulmonary metastases, usually bilateral, and accompanied by hilar infiltration in 20 per cent. Carcinoma of the prostate produced bilateral, fairly well circumscribed pulmonary lesions, and carcinoma of the bladder gave rise to either unilateral or bilateral metastases. Epithelioma of the uterine cervix produced well circumscribed metastases which were often unilateral, although there was a greater likelihood of bilateral involvement. Pulmonary lesions secondary to cystadenoma of the ovary resembled peritoneal extension in that a pleuritic exudate was produced either unilaterally or bilaterally in all cases. Metastatic pulmonary involvement from carcinoma of the large bowel was relatively frequent, but from carcinoma of the stomach it was rare. The pulmonary metastases from cancer of the kidney were usually bilateral, well circumscribed, and might be accompanied by hilar or mediastinal thickening. There was nothing distinctive about the metastases from primary bone lesions. From melanopithelioma and squamous-cell epithelioma they occurred more frequently than had been thought, and unilateral involvement predominated. Metastatic lesions from the former were well circumscribed and from the latter they were infiltrative. Carcinoma of the thyroid often spread by direct extension and was coincident with mediastinal and hilar thickening and accompanied by definite parenchymal lesions. Bagliani¹⁸ reports 12 cases to illustrate the value of the roentgen diagnosis for unsuspected pulmonary metastases. He says that in his clinic, carcinoma of the breast and stomach were the most frequent sources of metastases in the lungs. The second form of metastases has two forms: (1) *gen* carcinomatosa, and (2) *metastatica*. The former are radiograph, run

¹⁶Arch Otolaryng., October, 1930, XII, 446.

¹⁷RADIOLOGY, September, 1931, XVII, 435.

¹⁸Radiol. med.,

react to deep therapy; the latter are more chronic, the location varies, and therapy may give slight improvement. These latter may be secondary to sarcoma, and, if so, they react to therapy promptly. The apices are seldom the seat of malignant nodules. Matz¹⁹ found, from his statistical study of 319 malignant growths in ex-service men, that although the lungs were not a common primary site of cancer, metastatic involvement was frequent. His material is a compendium of information sent in by all the regional offices of the Veterans' Administration. The data indicate that the most satisfactory therapeutic results are obtained from the following methods or combinations in the order named: (1) radium, surgery, and roentgen irradiation; (2) X-ray; (3) surgery; (4) X-ray and radium, and (5) symptomatic therapy.

Therapy.—Meland,²⁰ writing on radiation therapy of carcinoma of the respiratory tract, stresses the prime importance of accuracy in diagnosis. Next, he advises biopsy of laryngeal and bronchial carcinomas to determine the type and to compute the amount of radiation necessary for eradication. And finally, he urges more frequent tracheotomy for palliation in advanced cases. Levin²¹ makes his deductions from twenty-five years' experience with cancers of the breast. He feels that the success of therapy depends on the stage of the disease and the type of involvement: the latter he judges by clinical criteria, not histologic, because they are more practical. The chief characteristic of the article is that it is a practical, commonsense approach to the problem of radiotherapy and surgery in cancer of the breast. He feels that, at present, advanced carcinoma presents the most pressing therapeutic problem.

Mediastinal Tumors.—Hosoi and Stew-

art²² analyzed and reported eight cases of different types of mediastinal tumor masses. They conclude that there is no single pathognomonic symptom or sign for a differential diagnosis; that metastasis to the central nervous system, which is common, may so dominate the symptomatology that a diagnosis of primary brain tumor is made; and that tuberculosis may be suspected in the very early stages because of the persistent cough due to bronchial irritation by the growing mass. For diagnosis, they depend on clinical observations correlated with the roentgen and laboratory data. The last may be obtained by examination of the sputum, pleural fluid, or tumor cells; examination of a specimen obtained by probatory puncture or through the bronchoscope, and from biopsy. Desjardins²³ admits the difficulty in diagnosing mediastinal tumors. He considers two types of growth, those which consist mostly of lymphatic cells and which respond rapidly to therapy, and those of other nature, such as carcinoma and sarcoma, except lymphosarcoma, which are more resistant. Davison²⁴ agrees with the belief that intrathoracic tumors, both benign and malignant, are more common now. He says that the benign tumors of the lungs and mediastinum often produce atelectasis and bronchiectasis by pressure. He remarks on the possibility of coexistence in one patient of (1) primary carcinoma and pulmonary tuberculosis, and (2) abscess and primary carcinoma. He urges surgery for accessible benign tumors, and says that early surgery is the only hope for primary malignant neoplasms within the chest, because in such conditions roentgen therapy is only palliative.

Tumors of the Wall of the Thorax.—Zimlinger's²⁵ report of tumors of the wall of the thorax, adds 27 more cases to the

¹⁹Med. Bull. Vet. Adm., November, December, 1931, VII, 1010, 1128.

²⁰Calif. and West. Med., March, 1931, XXXIV, 165.

²¹Jour. Am. Med. Assn., March 19, 1932, XCVIII, 977.

²²Arch. Int. Med., February, 1931, XLVII, 230.

²³Röntgenpraxis, July 15, 1931, III, 657.

²⁴Arch. Surg., December, 1930, Part 2, XXI, 1393.

²⁵Ann. Surg., December, 1930, XCII, 1043.

238 which he noted in the literature. He feels that early and radical surgical removal is the choice of treatment, although diagnosis is difficult before operation. He says that partial removal is unsatisfactory.

Lymphatic Tumors.—Roentgenotherapy of the lymphatic tumors seems to be valuable. Levin's²⁶ study of over five hundred cases of lymphoma malignum and lymphosarcoma discloses his belief that both conditions are malignant, that each is a different phase of the same entity, and that radiologic treatment must be of the involved areas and prophylactically of those into which it is likely to metastasize. Kirklin and Hefke²⁷ feel that roentgen examination of the thorax does not permit a precise diagnosis of Hodgkin's disease, lymphosarcoma, or leukemia, but that all of them must be considered as one group called either "lymphoblastoma" or "malignant lymphoma."

Rarities.—Among the cases of rare tumors reported is the one of Rosenbaum and Gasul²⁸ of primary sarcoma of the lungs in an infant; Kramer's²⁹ cases of adenoma of the bronchus, and Lemon's³⁰ group which includes (1) fibrosis and calcification; (2) hygroma; (3) lipoma; (4) fibroma; (5) myxoma (fibromyxosarcoma); (6) neurofibroma; (7) osteochondroma and chondroma, and (8) dermoid cyst and teratoma. Blumensaat's³¹ case of hypertrophic pneumonic osteoarthropathy is unusual because it was the result of a large metastatic melanoblastoma in the lung with multiple skin metastases. After roentgenotherapy the growth disappeared and there was improvement of the periosteal changes, especially in the hands and feet.

Coccidioidal Granuloma—Carter's³² article on coccidioidal granuloma is the result

of extensive bibliographic study. He offers a discussion of the features which confuse the diagnosis with tuberculosis and blastomycosis and other infectious granulomas. He says that the finding of the organism is positive for diagnosis, because the course and the roentgen appearance are so confusing.

TUMORS—ADDITIONAL BIBLIOGRAPHY

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²⁶Jour. Am. Med. Assn., Feb. 7, 1931, XCVI, 421.

²⁷Am. Jour. Roentgenol. and Rad. Ther., November, 1931, XXVI, 681.

²⁸Arch. Pediat., January, 1931, XLVIII, 63.

²⁹Ann. Otol., Rhin., and Laryng., 1930, XXXIX, 689.

³⁰Med. Clin. N. Am., July, 1931, XV, 17.

³¹Röntgenpraxis, Feb. 1, 1931, III, 134.

³²Am. Jour. Roentgenol. and Rad. Ther., June, 1931, XXV, 715.

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EFFUSIONS

Sagel and Rigler³³ studied mediastinal pleural effusion, and they conclude that it is not so infrequent as was formerly believed, but that it is often overlooked clinically because of difficulty in diagnosis. They describe the characteristic roentgen finding, a triangular shadow on either side of and continuous with the median shadow, and from which it cannot be separated regardless of position. Freedman³⁴ discusses both mediastinal and interlobar encapsulated effusions, giving the diagnostic criteria for each. "Interlobar effusions are characterized by sharply defined band or wedge-shaped or circular shadows in the region of the interlobar septa. In the presence of a pneumonia, the only roentgenologic sign of an interlobar effusion is the bulging of the interlobar fissure, seen in the lateral view. Mediastinal pleural effusions are represented as band, wedge-shaped, or triangular shadows parallel to the vertebral column or to the cardiac silhouette." He feels that bronchography is a valuable aid in the diagnosis of both types of effusions. For Bowen's³⁵ quantitative study of pleural effusions, he made postmortem chest roentgenograms of every deceased patient at Fitzsimons General Hospital. He checked the films against the autopsy findings, and endeavored to produce typical pleural effusions in the cadaver. The first procedure showed wide variation in demonstrating pleural effusions; in the second, no correspondence could be found between the films and the findings, and the

third was not successful because the vital factors are necessary to produce the typical configuration. He believes that while small effusions cannot be accurately estimated by radiography, films of suspected cases made in the lateral decubitus position offer the best method of demonstrating them. He also concludes that the failure to find fairly large effusions (400 to 600 c.c.), in numerous cases, either by physical diagnosis or by the roentgen examination, is due to the distribution of the fluid, which varies in different cases according to the combination of physical factors present. Post³⁶ states that a roentgen study of pleural effusion depicts increase of fluid, amount of lung compression and displacement of surrounding organs, re-establishment of any subsequent pleural thickening, adhesions or calcareous infiltration. He stresses the importance of fluoroscopic examination, and of both lateral and postero-anterior roentgenograms. He says that the interlobar encysted effusion, corresponding to one of the normal fissure levels, is seen on the postero-anterior roentgenogram as a band-like shadow of increased density across the affected hemithorax, while the medial encysted effusion appears as an additional shadow of increased density overlying the normal inferior mediastinal and heart shadows. Bauke³⁷ feels that although even a small amount of fluid in the pleural cavity can be shown by roentgen means when it accumulates in the lowest point, there is difficulty in the roentgen demonstration of the exudate which extends in a thin layer throughout the whole pleural cavity.

PLEURITIS AND PLEURISY

Schall³⁸ says that the cause of interlobar pleuritis is usually tuberculosis or pneumonia, the diagnosis is difficult except by means of the roentgenogram, and the course

³³*Am. Jour. Roentgenol. and Rad. Ther.*, September, 1930, XXIV, 225.

³⁴*RADIOLOGY*, January, 1931, XVI, 14.

³⁵*RADIOLOGY*, September, 1931, XVII, 520.

³⁶*Jour. Am. Inst. Homeop.*, October, 1931, XVII, 862.

³⁷*Med. Klin.*, July, 1931, XXVIII, 1032.

³⁸*Kinderärztl. Praxis*, February, 1931, II, 54.

is mild except when interlobar empyema occurs. He thinks many cases are misdiagnosed as epituberculosis, tuberculous infiltration, or non-syphilitic thickening. He and Hoffman³⁰ found that in good chest roentgenograms, a very fine line, either straight or slightly curved, can be seen in the right mid-chest. It is the "hairline" which Hotz and Schönfeld also found. They think it represents the interlobar pleura, but not necessarily old or recent interlobar pleurisy, as the normal may also cast this shadow in certain cases.

PLEURAL CALCIFICATIONS

Velde and Schlopsnies⁴⁰ state that calcification of the pleura takes place by encrustation with calcium salts; that the condition represents the final outcome after an exudative pleuritis, empyema, or hemothorax, and that in the living, it can be diagnosed only by means of the roentgen examination (both fluoroscopic and roentgenographic). Lamarque and Betoullieres⁴¹ believe that although radioscopically one cannot differentiate a plaque of slight calcification about which an advanced fibrous process exists, it may be done radiographically. They state that radiologically, the calcified processes are divided into three groups: (1) small isolated calcified spots, irregularly placed on the parietal pleura, of equal or greater density than the ribs, and usually accompanied by tracts; (2) calcified tracts in the form of non-homogeneous, branched, stalactite bands, irregular in diameter, of greater density than the ribs, and (3) calcareous shells which have a truly pathognomonic appearance. They compare the last to the skeleton of the cuttlefish, and describe a shell as made up of two curves opening one within and one without the thorax. The ends taper; the upper more sharply, and it extends as high as the third or fourth rib; the lower is

blunted by the diaphragmatic shadow in the frontal view. The great axis of the shell is parallel to, behind, and a little inside of, the post-axillary line. Fluoroscopically, the opacity seems uniform, but roentgenographically, it appears as either finely granular or cloudy. The mass presents a thin, dense band at the periphery which, in the tangential projection, appears as a calcareous shell. It resembles a calcified hydatid cyst. They also state that bloody effusion seems to affect the mode of calcification. As long as the evolution is aseptic, the calcification, which is made not in the effusion but in the region immediately subpleural to it, is regular and homogeneous, but if there is infection, it becomes irregular. Lippman⁴² describes three cases with small circumscribed areas of calcification in the pleura which remained stationary for years. He says they indicate only small, localized, harmless pleural scars, and are of little clinical significance. Hubrich's⁴³ patient showed an area of dense calcification in the roentgenogram made prior to a goiter operation. The author thought it must have been calcification of the pulmonary parenchyma resulting from an old injury which produced an hematoma and led to destruction and necrosis.

ACCESSORY LOBES

Gräberger's⁴⁴ contribution concerning triangular, basal, and mediastinal shadows is especially directed toward the signs which permit recognition of accessory lobes. He reviews the literature, and cites two cases of his own which showed basal, triangular shadows on the first roentgen examination, but which cleared later. A sharp line that resembled an interlobe remained as the lateral border of the previously diseased area. He cites three more cases which showed sharp lines in the inner portion of the right

³⁰Röntgenpraxis, Nov. 1, 1930, II, 977.

⁴⁰Röntgenpraxis, July 15, 1931, III, 634.

⁴¹Paris méd., Feb. 7, 1931, I, 129.

⁴²Röntgenpraxis, Aug. 1, 1931, III, 680.

⁴³Zentrbl. f. Chir., Jan. 2, 1932, LIX, 30.

⁴⁴Acta radiol., 1931, XII, 240.

base running obliquely upward toward the hilum, like interlobar lines between the upper and middle lobes. He explains the tent-shaped diaphragmatic adhesions seen in the medial portion of the base as organized exudate in the grooves which separate an accessory lobe from the rest of the lower lobe. He says that unless an accessory lobe is infiltrated or atelectatic, it will not be visible on the left through the heart shadow, and he illustrates his point with two cases. The straight lateral border of the basal shadow differentiates an accessory lobe from an encapsulated, basal, paramediastinal exudate whose lateral border is usually concave. However, the lateral border is straight also in atelectasis of the whole lower left lobe or of the right middle lobe, but in such cases other roentgen signs suggest the diagnosis of atelectasis. Debré and Mignon⁴⁵ describe the roentgen appearance of the azygos lobe. They say that on the film one sees a very fine, very regular shadow line at the right apex which runs to the upper section of the right hilus. This line describes either a rather large or rather small arc and extends from about the second to the fifth rib posteriorly. According to its course one may differentiate various types. The line begins in the apex in the shape of a little triangle and ends at the hilus as a thick homogeneous shadow (tear or drop), which can be easily confused with a line shadow. Inside the line, the transparency of the lung may be considerably decreased, thus permitting confusion with specific affection. Jabotinsky⁴⁶ feels that the presence of the azygos lobe is not exceptional. He found it in three of 1,400 roentgenograms and in two of 600 patients he examined. Shannon⁴⁷ reports four additional cases of this anomaly, and Brown and Braverman,⁴⁸ one. The unusual feature of the case reported by

the latter authors is that in the roentgenogram, instead of the inverted comma-like line along the area corresponding to the usual position of the azygos lobe, there was a uniformly dense shadow suggestive of consolidation, but which upon examination proved to be free of any abnormal changes. Loben's⁴⁹ observations on the azygos lobe are noteworthy because in one of his cases the condition was associated with tuberculosis, and in the other, he found the anomaly in both brother and sister. He feels that the latter indicates an occasional familial nature.

DIAPHRAGM

The large number of cases reported warrants the conclusion that diaphragmatic hernia, eventration, and thoracic stomach are conditions whose recognition is becoming more common. Moore and Kirklin⁵⁰ summarize the progress in the roentgenologic diagnosis of diaphragmatic hernia, and report 90 cases seen in the Mayo Clinic since 1924. They believe the condition is not so rare as it was previously thought to be. They emphasize the lack of knowledge of the clinical significance of small hiatus hernias, and note the difficulty of differentiating eventration from diaphragmatic hernia. Diemer's⁵¹ patient had two rare conditions—patulous esophageal pathway with gastric herniation, and massive atelectasis of the right middle lobe. There was no connection of the one with the other, and each was discovered rather accidentally.

PNEUMONIA

As a result of Kriegel's⁵² review of 125 cases of croupous and influenzal pneumonia, he lists five types morphologically: (1) massive homogeneous dullness of the involved lobe, the shadow more or less clear-cut; (2) mottled density in the diseased area, with

⁴⁵Rev. franc. de pediatrie, 1931, VII, 143.

⁴⁶Vestnik Rentgenol. i Radiol., 1930, VIII, 351.

⁴⁷Can. Med. Assn. Jour., April, 1931, XXIV, 498.

⁴⁸Radiology, September, 1931, XVII, 575.

⁴⁹Fortschr. a. d. Geb. d. Röntgenstrahlen, February, 1931, XLII, 231.

⁵⁰Jour. Am. Med. Assn., Dec. 27, 1930, XCV, 1966.

⁵¹Colorado Med., September, 1931, XXVIII, 414.

⁵²Ztschr. f. klin. Med., May 18, 1931, CXVI, 815.

more or less thickening and fleck-like areas distributed throughout, and occasional confluent fleck-like areas; (3) tortuous areas, with fleck-like shadows of rather indefinite outline; (4) the lung changes not so marked, some thickening and widening of hilus shadows, and (5) marked thickening and widening of the hilus only. He says that Types 3, 4, and 5 are of resolving pneumonia, and that in Types 3 and 4 it is necessary to differentiate from tuberculosis.

CHYLOTHORAX

There are two reports on chylothorax. The case reported by Van Nuys⁵³ was proved by examination of the aspirated fluid. After a review of the literature, the author finds that his is the sixty-sixth case reported, and, therefore, he concludes that the condition is a rare one. He treated the patient by aspiration and high voltage X-ray, and at the time of reporting, the patient was doing well. Cohn⁵⁴ reports a case which was difficult to diagnose because of obstructive phenomena. The diagnosis was confused with Hodgkin's disease, and enlarged mediastinal lymph nodes obstructed the thoracic duct and were found at autopsy. However, the final diagnosis was chylothorax and chylous ascites.

AIR CYSTS

Congenital air cyst of the lung is a condition which seems to be rare and difficult to differentiate in the roentgenogram from pneumothorax. Parmelee and Apfelbach⁵⁵ found it possible to recognize their case because there was complete absence of the characteristic hilus stump of pneumothorax, and the air-filled space could be seen outlined by a definite line, the wall of the cyst. Hünnerman and Sievers⁵⁶ report a case of

congenital cystic malformation of the lungs of a 14-day-old girl, saying it is the sixth case in the literature and the fourth diagnosed during life. In the roentgenogram, which is the only method of diagnosis during life, the diseased side is bright and the heart and mediastinum are pushed to the sound side; the collapsed stump of the lung is the differential note between pneumothorax and cyst. Eloesser⁵⁷ reports six cases of congenital cystic disease, three of each lung; one additional possible case of the left lung, and one other case not of that condition. He says there are two types, the infantile and the adult. The roentgenogram of the infantile form is similar to that of spontaneous pneumothorax; it reveals a straight shadow corresponding to the interlobar fissure and running across the translucent chest. A solitary cyst may cast a round mediastinal shadow or appear as an air-containing cavity lying either in the mediastinum or in the pulmonary parenchyma. In the adult type, the X-ray shows a curious system of whorls occupying usually the lower part of the lung field. If the whole lung is affected, the appearance is of a contracted gray hemithorax with a deviated mediastinum. Lipiodol injection often aids in the diagnosis. Dethmers⁵⁸ reports a case of a woman, aged 35 years, who was sent to the hospital with a diagnosis of pulmonary tuberculosis. The roentgenograms showed the whole right upper lobe filled with irregularly distributed small circular shadows which were thought to be congenital cysts. Lipiodol injection confirmed the diagnosis.

DERMOID AND HYDATID CYSTS

A number of dermoid and hydatid cysts are reported because of unusual features. In the case of Lamarque and Chaptal,⁵⁹ the interesting features were that several teeth

⁵³Calif. and West. Med., April, 1931, XXXIV, 269.

⁵⁴Am. Jour. Surg., February, 1931, XI, 260.

⁵⁵Am. Jour. Dis. Child., June, 1931, XLI, 1380.

⁵⁶Ztschr. f. Kinderh., 1930, L, 451.

⁵⁷RADIOLOGY, November, 1931, XVII, 912.

⁵⁸Acta radiol., April 15, 1931, XII, 135.

⁵⁹Jour. de radiol. et d'électrol., November, 1930, XIV, 592.

could be roentgenologically demonstrated within the shadow of the tumor mass, and the tumor had perforated into a bronchus and produced a fistula, with secondary infection. According to their figures, theirs is the 168th case published. A previously unpublished case of hydatid cyst was elicited in the discussion of Phillips⁶⁰ report of 34 cases. Jones, of Richmond, Virginia, says he reported the case but never published it.

OTHER CYSTS

The hematic cyst of the pleura reported by Huguet and Zucoli⁶¹ was calcified also. In Pinelli's⁶² case of paramediastinal echinococcus disease there was nothing to suggest a cyst. After X-ray examination, the diagnosis was made by clinical and radiological means.

EDEMA

Coe and Otell⁶³ were fortunate in obtaining a roentgenogram of the chest of their patient during the edematous stage as well as a second on the following day when there was considerable improvement in the acute pulmonary edema. They note the splotchy appearance on the film, and remark that apparently certain groups of alveoli become filled with fluid, while the remaining ones, particularly those at the periphery, are air-containing.

EMPHYSEMA

Hermes⁶⁴ studied 20 clinically proven cases of emphysema by comparison of the roentgen and spirographic records, and found that the roentgenogram is characterized by a pathologic contour of the thorax and abnormally bright lung fields. Previously this brightness had been explained as increased air content of the emphysematous lung or

as tissue degeneration or pulmonary anemia. He found that the total capacity of the lungs is not increased in emphysema, but is more often diminished. Kyphosis is a contributory factor in the increased brightness of the sagittal diameter. The highly prominent vascular markings of the emphysematous lungs are traceable to a contrast effect. Stasis of the pulmonary arteries appears as a basal intensified or increased shadow. Etiologically, the formation of definitely outlined lung markings is probably due to sclerosis of the pulmonary arteries.

ESOPHAGUS

An increasing amount of attention is being paid to varices and diverticula of the esophagus. Hjelm's⁶⁵ two cases of varices of the esophagus, diagnosed roentgenologically, prompt him to urge examination for these conditions in cases of hemorrhage from the digestive tract when the roentgen examinations of stomach and duodenum give negative results. He says remnants of a spoonful of contrast emulsion will lodge in grooves between the varices and they can be seen projecting into the lumen of the esophagus. If they are large and numerous, the fissure-like lumen of the empty esophagus, visible after the passage of the contrast medium, will be broader than normal. Pohlandt⁶⁶ says that the roentgen differential diagnosis between cancer and varicosities of the esophagus may be difficult because multiple small filling defects may be present in both. He says the only differentiation of importance is the slight narrowing and fixation of a cancer as compared with varicosities. Absence of normal elasticity and involvement of only a small portion of the esophagus are points which tend to indicate a malignant growth. Mac-Millan⁶⁷ reports that pharyngeal pouches were the cause of about 2 per cent and

⁶⁰Arch. Surg., December, 1930, XXI, 1324.

⁶¹Bull. et mêm. Soc. de radiol. méd. de France, December, 1930, XVIII, 464.

⁶²Arch. di radiol., May-June, 1931, VII, 570.

⁶³Am. Jour. Roentgenol. and Rad. Ther., January, 1932, XXVII, 101.

⁶⁴Biétr. z. Klin. d. Tuberk., April 18, 1931, LXXVII, 251.

⁶⁵Acta radiol., April 15, 1931, XII, 146.

⁶⁶Röntgenpraxis, Oct. 1, 1931, III, 889.

⁶⁷Jour. Am. Med. Assn., March 19, 1932, XCVIII, 964

esophageal pouches of less than 1 per cent of 1,000 cases of dysphagia which he reviews. The roentgenograms of Benassi's⁶⁸ two cases of essential permanent esophago-spasm in children showed a peculiar appearance caused by the projection of the mucous membrane contracted by the spasm. It was similar to the projection of the pyloric mucous membrane at the base of the duodenum, as described by Busi.

FOREIGN BODIES

Among the various foreign bodies reported are the usual number of safety pins, coins, and teeth. There was also a fountain-pen cap which was not opaque to the X-ray, and a piece of pork bone which could not be demonstrated on the film. McWhorter⁶⁹ calls attention to vegetable foreign bodies in the lungs as a source of severe laryngo-tracheo-bronchitis, if retained longer than a few hours. He reports six cases in which the various bodies were grains of corn, a piece of apple, and watermelon seeds. (Geography is evidently important, also!) There was one fatality, the rest making good recoveries.

PLEURAL MOUSE

Morlock and Woolh⁷⁰ report three cases of fibrin bodies in pneumothorax cavities, a condition which they term "pleural mouse."

SYPHILIS

McIntyre's⁷¹ article on pulmonary syphilis is an excellent compendium of the material on that subject. He states that the only points of differentiation are possibly the radiating fanlike lines seen in the X-ray films, and the location, which is usually in the lower lobe more especially on the right. Hammer⁷² also says recognition is difficult,

but he adds that there is some diagnostic value in localization in the mid-portion of the chest or in an absence of calcification. He reports two cases with the clinical histories, roentgenograms, and autopsy findings. Bergerhoff⁷³ feels that the roentgenogram is a great diagnostic aid in differentiating interstitial pulmonary syphilis. He reports three patients in whom anti-syphilitic treatment produced disappearance of the changes. He contends that such pulmonary changes are commoner than hitherto supposed. Herman⁷⁴ feels that syphilis of the lungs is a rare disease and easy to mistake for other chronic pulmonary diseases, but that the roentgen appearance alone is diagnostic, and the Wassermann examination and specific therapy assist.

ABSCESSSES

Fifty-five cases of anebic, hepatic, subphrenic, and pulmonary abscesses are reported. Sweany, Stadnichenko, and Henrichsen⁷⁵ report a case of multiple pulmonary abscesses caused by the Friedlander bacillus. The case is unusual because the bacillus grew better anaerobically than aerobically. Excepting the general appearance of the patient, the irregularity in temperature, and the obscure physical observations, clinically and roentgenologically, the condition resembled chronic pulmonary tuberculosis.

BRONCHIAL SPIROCHETOSIS

Mease⁷⁶ reports two cases of bronchial spirochetosis, and Talia⁷⁷ describes two cases with cavitation. The former urges correct dental hygiene to lessen the danger of lung infection. The latter made systematic radiographic observations for three or four

⁶⁸Radiol med., November, 1930, XVII, 1334

⁶⁹South Carolina Med. Assn. Jour., November, 1930, XXVI, 284

⁷⁰British Jour. Radiol., November, 1930, III, 515

⁷¹Arch. Path., February, 1931, XI, 258

⁷²Röntgenpraxis, April 1, 1931, III, 301.

⁷³Fortschr. a. d. Geb. d. Röntgenstrahlen, December, 1930, XLII, 478

⁷⁴Röntgenpraxis, Oct. 15, 1930, II, 916

⁷⁵Arch. Int. Med., April, 1931, XLVII, 565

⁷⁶Florida Med. Assn. Jour., February, 1931, XVII, 373

⁷⁷Radiol med., December, 1930, XII, 1370

could be roentgenologically demonstrated within the shadow of the tumor mass, and the tumor had perforated into a bronchus and produced a fistula, with secondary infection. According to their figures, theirs is the 168th case published. A previously unpublished case of hydatid cyst was elicited in the discussion of Phillips⁶⁰ report of 34 cases. Jones, of Richmond, Virginia, says he reported the case but never published it.

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as tissue degeneration or pulmonary anemia. He found that the total capacity of the lungs is not increased in emphysema, but is more often diminished. Kyphosis is a contributory factor in the increased brightness of the sagittal diameter. The highly prominent vascular markings of the emphysematous lungs are traceable to a contrast effect. Stasis of the pulmonary arteries appears as a basal intensified or increased shadow. Etiologically, the formation of definitely outlined lung markings is probably due to sclerosis of the pulmonary arteries.

ESOPHAGUS

An increasing amount of attention is being paid to varices and diverticula of the esophagus. Hjelm's⁶⁵ two cases of varices of the esophagus, diagnosed roentgenologically, prompt him to urge examination for these conditions in cases of hemorrhage from the digestive tract when the roentgen examinations of stomach and duodenum give negative results. He says remnants of a spoonful of contrast emulsion will lodge in grooves between the varices and they can be seen projecting into the lumen of the esophagus. If they are large and numerous, the fissure-like lumen of the empty esophagus, visible after the passage of the contrast medium, will be broader than normal. Pohlandt⁶⁶ says that the roentgen differential diagnosis between cancer and varicosities of the esophagus may be difficult because multiple small filling defects may be present in both. He says the only differentiation of importance is the slight narrowing and fixation of a cancer as compared with varicosities. Absence of normal elasticity and involvement of only a small portion of the esophagus are points which tend to indicate a malignant growth. Mac-Millan⁶⁷ reports that pharyngeal pouches were the cause of about 2 per cent and

⁶⁰Arch. Surg., December, 1930, XXI, 1324.

⁶¹Bull. et mém. Soc. de radiol. méd. de France, December, 1930, XVIII, 464.

⁶²Arch. di radiol., May-June, 1931, VII, 570.

⁶³Am. Jour. Roentgenol. and Rad. Ther., January, 1932, XXVII, 101.

⁶⁴Betr. z. Klin. d. Tuberk., April 18, 1931, LXXVII, 251.

⁶⁵Acta radiol., April 15, 1931, XII, 146.

⁶⁶Röntgenpraxis, Oct. 1, 1931, III, 889.

⁶⁷Jour. Am. Med. Assn., March 19, 1932, XCVIII, 964.

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weeks, and concludes that the cure is extremely slow, the radiologic characteristics are very like those of pulmonary abscesses, the reparation takes place centripetally, and radiologic examination aids in the diagnosis but biologic examination is necessary.

GOITER

Curtis⁷⁸ reviews the literature, and discusses 91 cases of intrathoracic goiter, 25 seen in Billings Hospital, Chicago, and 66 from Berne. He says the roentgen examination of the trachea is the conclusive diagnostic means.

TULAREMIA

Sante's⁷⁹ report of a case of tularemia is most valuable for the description of the pulmonary picture of this disease. In the lower portion of the right lung, he found an irregular area of consolidation, about 2.5 by 4 cm., which resembled the peribronchial infiltration seen in bronchopneumonia. There were tiny rarefied areas within the consolidation which may have been due to small abscess formation. There was no evidence of pathology elsewhere in either lung, and the heart and aorta appeared normal. Later, there was complete disappearance of the consolidation and a return to the normal, as well as uneventful recovery.

PERTUSSIS

Popischill and Feyrter,⁸⁰ of Vienna, made histologic examinations of 100 cases of pertussis, and they were able to show characteristic lesions, the nucleus of which was a peribronchitis. Radiologic examinations by Corcan, of Strasburg, confirmed their observations. He found roentgenologic evidence of constant changes, characterized by tracheobronchial adenopathy and by peribronchial shadows that descend along the

hila toward the diaphragm. In grave cases, these produce a triangular image with its base on the diaphragm. The typical lesions of the disease which are revealed on the roentgenogram persist a long time after the paroxysms of coughing have ceased.

MAMMARY GLAND

Warren⁸¹ believes roentgen examination of the mammary gland is of definite diagnostic value, and he describes his technic and tabulates his results. Seabold⁸² agrees with him, but he urges the need for comparative knowledge of the normal breast under various conditions.

STERNUM

Löw-Beer⁸³ says that the roentgen demonstration of the sternum is somewhat difficult as it must be projected away from the shadow of the spine and the mediastinum, and that both neoplastic and inflammatory processes may produce destruction. In his six cases, four were from tumors, either benign or malignant; one was from syphilis, and one, from chronic osteomyelitis. In the last two, the changes were localized in the manubrium.

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⁷⁸*Jour. Am. Med. Assn.*, March 7, 1931, XXVI, 737.

⁷⁹*Am. Jour. Roentgenol. and Rad. Ther.*, February, 1931, XXV, 241.

⁸⁰*Jour. Am. Med. Assn.*, March 7, 1931, XCVI, 787.

⁸¹*Am. Jour. Roentgenol. and Rad. Ther.*, August, 1930, XXIV, 113.

⁸²*Surg., Gynec. and Obst.*, October, 1931, LXII, 461.

⁸³*Röntgenpraxis*, Sept. 15, 1931, III, 817.

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EXPERIMENTAL

Experimental studies which particularly pertain to radiology are few. Meller⁸⁴ is studying the anatomy of the pulmonary lymphatics, but he has no conclusions yet. Schall and Hoffman⁸⁵ were able to demonstrate the anatomy of the interlobar fissures in cadavers which they roentgenographed. According to Brdiczka and Wolf,⁸⁶ the normal interlobar fissure is the hair-line on the X-ray film. They state that it is found in about 42 per cent of normal cases, and that moderate thickening indicates an old pleuritic process, and marked thickening indicates interlobar adhesions. Miller⁸⁷ did some postmortem experimental work to determine whether calcified nodes and nodules can be seen on the roentgenogram. He feels that they can be recognized on the carefully taken film made with short exposure and synchronized with diastole. Meller and Menkes⁸⁸ found from their roentgenographic studies of child cadaver lungs which they

⁸⁴*Fortschr. a. d. Geb. d. Röntgenstrahlen*, January, 1931, XLIII, 66.

⁸⁵*Fortschr. a. d. Geb. d. Röntgenstrahlen*, December, 1930, XLII, 714.

⁸⁶*Röntgenpraxis*, Nov. 15, 1930, II, 1014.

⁸⁷*Am. Jour. Roentgenol. and Rad. Ther.*, August, 1931, XXVI, 191.

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APPARATUS AND TECHNIC

Great advances are being made in the field of radiology, in the perfection of apparatus. The most outstanding of these is the presentation of equipment which will deliver 1,000 milliamperes routinely for diagnostic purposes.

Iodine Compounds.—Testimonials as to the value and limitations of the iodine compounds for diagnostic purposes may be found in abundance. Also, there are a number of reports of the varying methods of administering the compounds. (See the appended bibliography.)

Lateral Position.—The lateral roentgenogram has several staunch supporters. Brown⁹⁶ finds that in the lateral view, the diaphragm is pushed up by subphrenic abscess. He and Reinecke⁹⁷ found the lateral position especially valuable in the roentgen diagnosis of the superior and posterior mediastinum, and de Beaujeu⁹⁸ advocates its use as the only one which gives a view of the posterior and anterior mediastinum and the base of the lungs posteriorly. He feels it permits exact location of a pathologic process in the chest. Warfield⁹⁹ thinks it is im-

portant in localizing foreign bodies, in determining lung pathology, enlarged thymus, and in bronchiectasis with lipiodol injection.

Other Positions.—Other diagnostic positions are described by roentgenologists both in the United States and abroad. Rigler's^{100, 101} lateral decubitus position and the recumbent position with the affected side down, of Hjelm and Laurell,¹⁰² are probably similar as the former is valuable in demonstrating pleural effusions and the latter for pleural exudates.

Stereoscopy.—Stereoscopic roentgenography of the chest has long been accorded its proper place as a valuable diagnostic procedure, but there is a recent tendency toward more accurate methods of taking and viewing the stereoscopic roentgenogram. Sweany¹⁰³ studied the mechanical features which produce distortion, and he and Kegerreis and Cook¹⁰⁴ undertook consideration of the sources of error in intrathoracic localizations by stereoroentgenography. Their conclusions only emphasize anew the value of suspending as much movement as possible and consequently reducing the time. In England, the roentgenogram of the whole chest is evidently not a routine procedure. At a recent meeting, opinions were expressed on the value or lack of it of the stereoscopic examination of the chest. Stott¹⁰⁵ feels that because of almost insurmountable difficulties in stereoscopic thorax examination, for the clinician, the anteroposterior and lateral views are more dependable. He and Cruickshank¹⁰⁶ realize that the theoretical desideratum, namely, two films taken at the same instant under the same conditions, is physically impossible.

⁹⁶Jour. Am. Med. Assn., Jan. 10, 1931, XCVI, 104.

⁹⁷Am. Jour. Roentgenol. and Rad. Ther., February, 1931, XXV, 220.

⁹⁸Upsala Läk. Förh., Aug. 15, 1931, XXXVI, 305.

⁹⁹Am. Jour. Roentgenol. and Rad. Ther., February, 1932, XXVII, 257.

¹⁰⁰RADIOLOGY, February, 1932, XVIII, 277.

¹⁰¹Tubercle, September, 1931, XII, 539.

¹⁰²Tubercle, April, 1931, XII, 289.

⁹⁶Jour. Am. Med. Assn., Sept. 5, 1931, XCVII, 678.

⁹⁷Am. Jour. Surg., December, 1930, X, 452.

⁹⁸Jour. de radiol. et d'électrol., March, 1931, XV, 129.

⁹⁹Illinois Med. Jour., December, 1930, LVIII, 461.

hydrated and reinflated under identical conditions, that during the stage of hydration there is a marked increase in pulmonary markings. They feel that more attention should be paid to the mesodermic pulmonary structures in roentgen interpretation.

Hypoventilation.—Overholt's⁸⁹ experimental work on dogs showed that the introduction of air into the peritoneal cavity either by injection or as a result of laparotomy, caused the diaphragm to assume a higher position and restricted its excursion definitely. Observations of hypoventilation in humans led the same investigator⁹⁰ to conclude that a marked degree of pulmonary hypoventilation exists for a variable period of time after abdominal operations. This is caused by a high position of the diaphragm and restriction of the diaphragmatic excursions. He deduces that the opening of the abdomen and the entrance of air permit the negative intrapleural pressure to draw the diaphragm higher in the thorax, and there is also a reflex splinting of the abdominal musculature because of pain. Janker⁹¹ made some experiments on dogs to show the effect of changes in pressure within the thoracic cavity. He used the roentgencinematograph for recording his findings, and he feels that this device offers great possibilities in teaching demonstration and for experimental purposes.

Scalds.—Cordier and Magne⁹² were anxious to know why circulatory and renal disorders follow the inhalation of steam. By experiments on animals, they found that scalds of the respiratory tract as a result of such inhalation are followed by absorption of toxic substances coming from the disintegration of the affected tissues, and that these poisons pass into the general circulation and are capable of causing the death of the animal.

Pneumonia.—Terrell and Robertson⁹³ were able to produce pneumonia in dogs by intrabronchial injection of 18-hour cultures of *Pneumococcus* Types I and II. They injected the material under fluoroscopic guidance, into a small bronchus as near the periphery as possible. As a rule, a typical lobar consolidation appeared within twenty-four hours. The condition manifested was similar to human disease in manner of spread; localization of process; immune response; abrupt termination by crisis, lysis, or death, and rapid regression of the process after recovery. It differed from the human disease in that there was a great degree of blood-vessel engorgement throughout the condition, a smaller amount of fibrin, and more rapid decrease in size of the resolving lung.

Post-measles.—Kohn and Koiransky⁹⁴ report roentgen re-examination of the chests of 56 children from six to ten months after measles. They found that abnormal intensity of the pulmonary markings as described during measles was no longer seen, previous pneumonic infiltrations showed little residual or no pulmonary changes, and the changes were described as localized accentuation of the pulmonary markings. In some cases, pleural thickening which had not been present during measles was seen at the site of the interlobar fissure between the upper and middle lobes of the right lung, or in some other portion of the pleura. This involvement occurred often in cases considered clinically mild. The density of size and the hilar shadows had diminished.

Old Tuberculin Injections.—The experimental work of Austrian and Willis⁹⁵ on the effects of intratracheal injections of Old Tuberculin in rabbits which had already had pulmonary tuberculosis, shows that focal areas of inflammation develop that are anal-

⁸⁹Arch. Surg., December, 1930, XXI, 1282.

⁹⁰Jour. Am. Med. Assn., Nov. 15, 1930, XCV, 1484.

⁹¹Deutsche Ztschr. f. Chir., Aug. 24, 1931, CCXXXII, 570.

⁹²Ann. de physiol., 1930, VI, 584.

⁹³Proc. Soc. Exper. Biol. and Med., June, 1930, XXVII, 973.

⁹⁴Am. Jour. Dis. Child., March, 1931, XLI, 500.

⁹⁵Am. Rev. Tuberc., March, 1931, XXIII, 310.

THERAPY

Animal Experiment.—Lüdin and Wertheimann¹⁰⁷ were motivated by the description given by a number of clinicians of the changes in the lung following intense X-ray therapy over the chest. They experimented on two groups of animals, using two different-sized areas, and the same dosage and other factors. They treated the animals until they died. The pathologic changes found were essentially bronchopneumonia with exudative bronchitis and edema of the lungs with extensive proliferative processes in the epithelium of the bronchi. Sometimes the changes resembled the histologic picture found in carcinoma. Krebs, Rask-Nielsen, and Wagner¹⁰⁸ report that lymphosarcoma tissue from irradiated white mice, when implanted in other mice, did not take when the dose was two erythema doses, and the percentage of takes was considerably reduced when the dose was from one to one and five-tenths. Also, one to two erythema doses often had an inhibitory effect on lymphosarcomas from the size of a pea to that of a walnut, in live animals. The authors conclude that, from the fact that two erythema doses do not always produce such complete disappearance, the effect of the irradiation on the tumor tissue *in vitro* is not absolutely lethal, but only sufficiently inhibitory to prevent it, when implanted, from overcoming the natural resistance of the organism.

Radium (Breast).—Deutwitz¹⁰⁹ treated with radium two cases of bleeding breast. Both cases were well, one twelve years after treatment, and the other, seventeen years after. He advises its use in patients who refuse operation, and in those upon whom the surgeon hesitates to operate because he can find no definite tumor mass. He details technic, and refers to 22 cases by Hirsch.

Röntgen (Lymphogranulomatosis).—Billich¹¹⁰ uses roentgen therapy to lengthen life and as a palliative measure for lymphogranulomatosis. In 31 cases, in all of which the diagnosis was confirmed histologically, 35.5 per cent lived two years or longer, 29 per cent lived three years or longer, and one boy of nine years was alive five years later, with no evidence of the disease. Billich irradiates the glands only.

Röntgen (Asthma).—Zipperlen¹¹¹ tried roentgen therapy in bronchial asthma about 1906, after Schilling reported improvement by means of it. However, the former was dissatisfied and discontinued its use. Five years ago, he began the systematic use of the X-rays in treatment of the condition. He reports his technic and 15 cases cured, 15 improved, and 9 upon which there was no noticeable effect. Gonzales¹¹² recognizes five types of bronchial asthma according to the etiology. He uses roentgen therapy during the intervals between attacks in asthma associated with tracheobronchial adenopathy or chronic bronchitis, and sometimes he irradiates the spleen in asthma caused by anaphylaxis. He says there are conflicting opinions as to the value of therapy in asthma associated with pulmonary tuberculosis.

Röntgen (Pneumonia).—Merritt and McPeak¹¹³ used roentgen irradiation to stimulate delayed resolution of a case of lobar pneumonia before they knew it had been used in that way by Edsall and Pemberton in 1907. It was so successful for their first patient that they standardized the procedure and used it on six more. All but one responded well; four cleared entirely; two improved definitely, and the one was unchanged. (In this case the diagnosis was not positively pneumonia.) They suggest using irradiation in all pneumonias which evince delayed resolution three weeks after the onset.

¹⁰⁷Strahlentherapie, Nov. 29, 1930, XXXVIII, 684.

¹⁰⁸Acta radiol., Nov. 15, 1930, II, 487.

¹⁰⁹Strahlentherapie, 1930, XXXVIII, 710.

¹¹⁰Strahlentherapie, 1930, XXXVIII, 141.

¹¹¹Strahlentherapie, 1930, XXXVIII, 88.

¹¹²Arch. esp. de ped., September, 1930, XIV, 545.

¹¹³Radiol. Rev. etc., February, 1931, LIII, 31.

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HEPATOLIENOGRAPHY WITH THE USE OF THOROTRAST¹

By C. H. WARFIELD, M.D., Director, Department of Roentgenology, Cook County Hospital, CHICAGO

FOR many years, although it has been possible to visualize the size of the liver and spleen by pneumoperitoneum, it has been impossible to visualize gross lesions within these organs. Now a method has been advanced by which the density of the normal liver and spleen can be increased and the gross pathologic lesions remain of the same density as before.

Keith and Briggs (1), using an iodized rapeseed oil, visualized the spleen while attempting to visualize the blood vessels. Owing to the danger of oil embolism, this method never gained popularity and was not tried on patients. The author used the same material, producing death in dogs and rabbits. Later Radt (2), using a solution of thorium dioxide, was able to visualize the liver and spleen in animals. He then used it in humans, demonstrating gross changes in the liver and spleen. At this time, he felt that thorium was a toxic substance when injected in large doses, and so he gave repeated small doses without any clinical danger to the patient. Oka (3) later repeated this work with thorium dioxide, using about the same technic. He came to the same conclusions as Radt, except that he theorized that the cells of the reticulo-endothelial system were destroyed. He showed definitely that injections of adrenalin caused no change in the density of the spleen, and also that large doses caused a decrease in the red blood corpuscles and hemoglobin as well as the mononuclear leukocytes, transitional cells, and platelets in rabbits. Six cases, with no bad results, were reported.

Probably the best, as well as the most scientific and extensive, work has been done by Kadrnka (4). Using a stabilized thorium

¹I wish to thank A. J. Toman, M.D., and W. L. Benshek, M.D., for their splendid help, and the Heyden Chemical Corporation for supplying the thorotrast



Fig 1. Barium enema showing the defect of the cecum prior to resection.

dioxide solution known as thorotrast (Heyden), he has conducted extensive experiments on animals and has carried this work on in patients with good results and no reported deaths.

His technic consisted of small doses for several days. The first dose was 0.1 c.c. per kg. of body weight, then increased 0.1 c.c. for each succeeding dose up to five doses, the total amount not exceeding from 0.8 to 1 c.c. per kg. of body weight. He proposed that small amounts of thorotrast increased the resistance of the patient.

Thorotrast (Heyden) is a stabilized colloidal solution containing 25 per cent thorium dioxide. It is miscible with all body

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"Progress in Radiology during 1931" to be continued .

Oxygen Artificially Disintegrated by Using Neutron Projectiles.—Oxygen has been artificially disintegrated by bombardment with neutrons in experiments at the famous Cavendish laboratory at Cambridge, it has been announced in a communication to the British scientific journal, *Nature*, by Dr. N. Feather, of Cambridge. Photographs were obtained of the recoil and paired tracks of the results of the disintegration produced in an oxygen-filled expansion chamber. Polonium and beryllium at the center of the chamber provided the neutrons which hit and smashed the oxygen atoms.

The capture of the incident neutron seems

likely in all observations made by Dr. Feather, and he concludes that the disintegration particle is almost certainly an alpha particle or the heart of a helium atom.

The results show an absorption of energy and confirm the suggestion made recently by Mme. Curie that a small fraction of the beryllium radiation has a higher energy than the previous upper limit.

Although Lord Rutherford in 1919 and succeeding years performed the first artificial disintegrations of a number of elements, notably nitrogen, by bombardment with alpha rays, he did not break down oxygen. His colleague has now done so, using neutrons.—*Science Service.*



Fig. 4. Film of a metastatic liver that was not injected with thorotrast.



Fig. 5. This film of the liver was taken after autopsy to show the many areas of lessened density, representing the metastases. Note also the increased density of the normal liver.

film considerably, there was not the slightest change visible caused by the thorotrast."

In a personal communication regarding the radio-activity of this amount of thorotrast, Roy Kegerreis, M.D., says that it is a negligible amount, and less, since it is spread over such a large surface. Our simple test, placing the liver on an X-ray film for 36 hours, showed no images.

Nothing is known regarding the elimination of thorotrast. Kadrnka (5), who observed it three months after injection, states that the density of the liver and spleen had decreased about 50 per cent. Bauke (7) showed a slight decrease in density two months after injection. Baumann and Schilling (6) injected adrenalin to speed up elimination, but with no results. Buengeler and Krautwig (8) state that thorotrast is dangerous, since we know nothing of its elimination or radio-activity over a long period of time. They also state that it is poisonous in large doses. Dr. Jaffe states that, several months after the injection of colloidal gold, one sees it massed in a few cells, the other cells giving up the pigment and assuming their normal appearance. It is possible that thorotrast will have the same properties.

Practically all authors agree on the technique of injection, namely, the fractional

method. A total of from 0.8 to 1 c.c. per kg. of body weight is needed to bring satisfactory results. It is best to inject 0.1 c.c. per kg. for the initial dose. The next four doses should be 0.2 c.c., 0.2 c.c., 0.2 c.c., and 0.3 c.c. per kg., respectively. Injections should be made daily until the fifth dose has been administered. The total dose does not need to exceed 75 c.c.; in fact, we obtained good results with 50 c.c. as our total dose. The films are made 24 hours after the last injection. We employed the Potter-Bucky diaphragm, using low voltage and long time exposures to obtain maximum contrast.

Case 1 The patient, a male, aged 38 years, entered the Cook County Hospital on April 4, 1931, with symptoms of increased constipation and cramp-like pain in the right lower quadrant. These were interpreted as a carcinoma of the cecum, a diagnosis which was verified by roentgen examination. The cecum was removed, as well as the involved regional lymph glands, and a lateral anastomosis of the ileum and sigmoid was effected. The patient made an uneventful recovery and, except for diarrhea, was free from symptoms for several months. However, for the six months preceding the



Fig. 2. Preliminary film of the abdomen before injection of thorotrast to show the uniform density of the right side of the abdomen.



Fig. 3. The appearance of the liver shadow after the injection of thorotrast. Note the many irregular areas of lessened density in the liver shadow, indicating the metastatic lesions.

fluids without being flocculated or otherwise affected. It is very stable, milky in reflected light, and a transparent, colorless, or brownish solution in transmitted light. It is put up in sterile ampules and is not poisonous, nor is it resorbed. The above chemical statements have been confirmed by Dr. Gross, Institute of Pharmacology, University of Leipzig.²

Baumann and Schilling (6) quote Aschoff regarding the pathology of the liver and spleen following the injection of thorotrast, which work was done on animals. Aschoff states that, 15 minutes after the injection of thorotrast, one sees in the liver of rabbits small, shining, unstained particles in Kupfer's cells and the reticulo-endothelial cells of the spleen pulp. Twenty-four hours after injection, these cells are loaded with large, shining, silvery particles. In 14 days, the cells, which are swollen to the size of liver cells, still contain the large, shining, silvery particles. At the present time, no further pathologic data have been quoted nor reasons given why thorium dioxide is stored by the reticulo-endothelial system

I am indebted to R. H. Jaffe, M.D., pathologist to the Cook County Hospital, for describing the mechanism of storage of the thorium by the reticulo-endothelial system. Thorium dioxide, like other electronegative colloids of proper dispersity, is quickly absorbed by these cells, which later take it in and precipitate it by way of intracellular flocculation. Thus, the colloidal metal becomes visible as highly refractile cellular inclusions of various shapes.

The radio-activity of thorotrast should be considered, since it contains 25 per cent of thorium dioxide, which is a radio-active element. Kadrnka (5) quotes the Radium Institute of the Mining Academy of the University of Freiburg, which examined thorotrast for its radio-activity. In 100 c.c. amounts, it contains radio-active substance, the gamma radiation of which is equivalent to the gamma radiation of 1.24×10^{-6} radium.

Baumann and Schilling (6) state that a radium element of the strength $+3.6 \times 10^{-5}$ "and a certain amount of thorotrast were put on an X-ray film for 48 hours and then developed. While the radium blackened the

²As quoted by the Heyden Chemical Corporation

16 cm. in length. The sclerae were slightly icteric.

Abdominal Cavity.—Midline fat was practically absent. The cavity contained about 200 c.c. of clear, yellow fluid. The liver was 6 cm. below the xiphoid and 4 cm. below the right costal margin. There was a firm, yellow-gray mass, 4 cm. in length, protruding from the inferior surface of the liver. One of the loops of the ileum was firmly adherent to the abdominal scar, with firm, whitish nodules, 1 cm. in height, present along the line of adhesion.

Pleural Cavities.—Diaphragm: left, fifth interspace; right, indeterminate. The left cavity contained about 1,500 c.c. of clear yellow fluid. The right exhibited focal, fibrous adhesions at the base and apex, and contained about 250 c.c. of clear, yellow fluid.

Pericardial Sac.—This sac contained about 50 c.c. of clear yellow fluid.

Heart.—This organ weighed 200 grams. The left ventricle was 15 mm., the right, 2 millimeters. The myocardium was purple-brown, soft and friable.

Aorta.—The size was 64, 41, and 26 millimeters at three different levels. Single, hyaline plaques were seen *in ascendens*.

Arteries.—The coronaries exhibited a few hyaline plaques, but were otherwise thin-walled.

Lungs.—These were distended and ranged from crepitant to subcrepitant throughout. The hilus lymph glands, some of which were as large as 5 cm. in diameter, were firm, purple-gray, mottled with black. On section, the right lung was seen to be yellow-gray and moist. The lower lobe was non-crepitant. The left lung was yellow-gray. Sectioned surfaces were found to be moderately moist.

Thyroid.—The gland, which weighed 5 gms., was uniformly finely granular.

Stomach.—Along the lesser curvature of this organ was a linear arrangement of



Fig. 7. Gross specimen of the liver, showing the large metastatic lesions.

nodes up to $2.5 \times 1.5 \times 1$ cm. in diameter. The glands about the cardia were firm, up to 15 cm. in diameter and yellow-gray. On section, the mucosa was found to be smooth; the rugae were distinct and thrown into small mammillary folds.

Spleen.—The weight was 150 grams. The capsule was thickened and purple-gray with single, yellow-gray plaques. A sectioned surface was seen to be purple-red with indistinct follicles.

Liver.—The liver, which weighed 3,460 gms., was firm and deformed by numerous nodes up to 6 cm. in height. Many of these had a soft center and were raised above the hepatic surface. On the upper surface, the organ was closely adherent to the diaphragm. A sectioned surface was seen to be studded by nodes as previously described, one on the surface reaching for 7 cm. into the parenchyma. The parenchyma was purple-brown; the markings were obscured.

Pancreas.—This gland was $16 \times 3.5 \times 2$ cm. in size, yellow-gray and lobulated. The



Fig. 6. No. 1 is the spleen which has been injected with thorotrast. No. 2 has not been injected. Note the markedly increased density caused by thorotrast.

present examination, he has noticed loss of weight, marked weakness, and shortness of breath.

Physical examination showed an emaciated, colored male with temperature of 102.2° F., respiration 26, pulse 104, and blood pressure of 130/0. The essential findings were: fluid in the right pleural cavity, masses in the right lower quadrant, and an enlarged, nodular liver. The impression was of metastases to the liver and local recurrence of the primary tumor.

We chose this as our first case, since we had the pathologic diagnosis of the primary tumor, a palpable, nodular liver, and permission for autopsy. For a control, we first made a preliminary film of the upper abdomen. As the patient weighed 53 kg., the following amounts of thorotrast were given:

- First day, 5.3 c.c.;
- Second day, 10.6 c.c.;
- Third day, 10.6 c.c.;
- Fourth day, 10.6 c.c.;
- Fifth day, 15.9 c.c.

Each day a very careful clinical check was made on the patient to determine if there were any signs of reaction. Through these, we are able to say that the injections were uneventful; in fact, they were like those of normal saline. We feel safe in saying that, in the four cases injected, we had not the slightest reaction.

In 24 hours after the last injection we made films which showed very clearly the metastatic lesions. While the patient died a few weeks later with the usual terminal findings of a metastatic carcinoma, we feel sure that the thorotrast did not precipitate his death.

The following is a detailed report from the Department of Pathology.

Anatomic Diagnosis.—Metastases of a recurrent adenocarcinoma of the cecum, to the liver, the peripancreatic, peribiliary, perigastric, peri-aortic, mesenteric, and pulmonary hilus lymph nodes, and to both adrenals, the right kidney, and the greater omentum. Surgical removal of the cecum, the lowermost portion of the ileum, and the ascending portion of the colon, with an ileosigmoidostomy. Localized recurrence of the primary tumor at the site of the ileosigmoidostomy and in the peritoneum at the line of the abdominal incision. Healed laparotomy wound. Parenchymatous degeneration of the myocardium and kidneys. Softening of the spleen. Bilateral hydrothorax and hydropericardium. Ascites and edema of the ankles. Thorium dioxide deposits in the Kupffer cells of the liver, the reticular cells of the splenic pulp and bone marrow, sinus endothelium of the axillary lymph nodes, and stroma of the kidneys.

External Findings.—The subject was an emaciated, colored male. The pupils were equal and dilated, the lips and finger nails cyanotic, the abdomen slightly distended. There was slight pitting edema of the ankles. There was an ancient, healed, para-rectal laparotomy wound on the right side,



Fig. 10. A case of splenomyelogenous leukemia before injection with thorotrast.



Fig. 11. Same patient as in Figure 10, after injection of thorotrast. Note the increased density of the spleen as well as its outline.

flattened convolutions; vessels at base of brain.

MICROSCOPIC EXAMINATION

Bone Marrow.—The fat tissue was partly replaced by pale stained, finely fibrillar material, which seemed to have accumulated in the body of the fat cells. Scattered between these structures were small groups of lymphocytes and normoblasts. The reticular cells were filled by highly refractive, light gray-brown to yellow-gray crystals.

Adrenal.—This gland was almost completely replaced by tumor tissue which showed extensive regressive changes. The glandular structure of the tumor was well maintained; between the glands there was a delicate stroma.

Liver.—The Kupffer cells, which were very much swollen and increased in number, were stuffed by small, highly refractile, light gray to yellowish-gray crystals. In the numerous metastases similar cells were present. They were found in the stroma between the tumor cells and were quite numerous, though less numerous than in the liver

parenchyma. The liver cells were small and atrophic, containing darker brown pigment granules. The crystals in the Kupffer cells and in the stroma of the metastasis did not give the iron reaction.

Spleen.—The sinuses, which were wide, contained only a few small round cells and mononuclear, large phagocytes. The endothelium was swollen, but free from pigment. The reticular cells of the pulp were swollen, being filled by grayish-brown and light gray granules which gave a distinct iron reaction. In the meshes of the pulp were numerous plasma cells. The follicles were small and lymphocytic.

Lung.—The wide alveoli contained single cells filled by coal pigment. There were no thorium-containing elements present. The alveolar septa were thin and moderately cellular.

Axillary Lymph Gland.—The sinuses were wide and filled by proliferated endothelial cells which contained much of the light gray, highly refractile pigment.

Kidney.—There was a circumscribed

peripancreatic glands formed a mass measuring $5 \times 3 \times 4$ centimeters

Intestines.—The large intestine was pale purple-pink, with the mucosa covered by mucus. The small intestine was similar

seen to be entirely replaced by firm, yellow nodules, up to 2 cm in size.

Kidneys—The kidneys, which were firm, weighed 260 grams. In the right kidney, the lower and upper poles each presented a

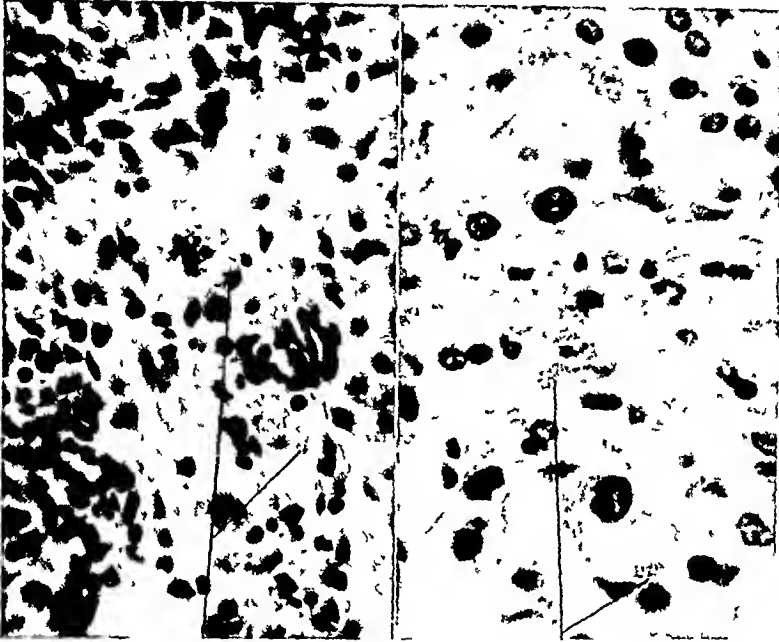


Fig 8 (left) Lymph node, showing the thorium dioxide crystals in proliferated sinus endothelium ($\times 1,200$)

Fig 9 (right) Liver, showing the Kupfer cells filled by crystals of thorium dioxide ($\times 1,200$)

There was a surgical anastomosis between the ileum and the sigmoid. There were many firm nodules, up to 3 cm in height, which had infiltrated the wall of the ileum and sigmoid and were also present over the line of surgical interference. At the angle of anastomosis was a cyst, 2 cm. in diameter, containing clear, straw-colored fluid. The surface nodes penetrated the wall but the mucosa was intact. The anastomotic ostium, which was 1.5 cm in diameter, showed no nodular invasion.

Adrenals—The adrenals, which weighed 130 gms., were firm and covered by fibrous adhesions. On section, the parenchyma was

node 1 cm in diameter. The capsule was stripped with slight difficulty, leaving a smooth, purple-gray surface. Sectioned surface showed the cortex to be 8 mm., with fairly distinct markings; the pelvic mucosa was pale.

Pelvic Organs—The mucosa of the urinary bladder was pale. The prostate was $3.5 \times 1.5 \times 2$ cm., firm and purple-pink. Several prostatic veins were thrombotic.

Bone Marrow—The marrow was soft, brownish-gray, and quite fatty.

Brain—The brain, which weighed 1,280 gms., was of soft consistency, with slightly

be jaundice and fever, but we do not feel that there is any danger in anemias, leukopenias, or the leukemias.

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Cosmic-ray Intensity Increases with Latitude.—Cosmic rays do not bombard the earth with equal intensity from all directions but their strength increases with the distance north and south of the earth's equator, Dr. A. H. Compton, Nobel prize physicist of the University of Chicago, reports.

This results from an extensive world-wide survey during which many physicists have made observations in remote localities. Dr. Compton transmitted this initial report from the Tasman Sea, during travel to new observing stations after research at Hawaii, New Zealand, and Australia.

The definite differences in the intensity of the cosmic rays at different latitudes are likely to upset present ideas of the origin and nature of the cosmic radiation. Dr. Robert A. Millikan, of the California Institute of Technology, like Dr. Compton a Nobel prizeman, has consistently found that the intensity of the cosmic radiation is independent of the latitude at which the observations are made. Dr. Compton's report does not confirm Dr. Millikan's findings.

Dr. Millikan has suggested that the cosmic rays may be the birth cries of the synthesis of heavy elements out of hydrogen and helium in the depths of the universe. This theory is

based upon his findings from wide-flung researches that cosmic radiation bombards the earth equally from all directions. With Dr. Compton's report this theory is likely to lose support. Dr. Compton reports that so far as the measurements have gone they indicate "uniform variation with latitude, showing a minimum at or near the equator and increasing intensity toward the north and south poles."

At sea level, the difference between intensity at latitude 45° and 0° is roughly 16 per cent, whereas at an elevation of 9,000 feet the difference is about 23 per cent. This would indicate, Dr. Compton says, that it is the least penetrating part of the cosmic rays which varies most rapidly with latitude. No significant variations with longitude have been noted.

Observations recorded in Dr. Compton's report include those made from Mt. Evans in the United States, from the Jungfrauoch in Switzerland, as well as the measurements made by Dr. Compton and associates during this present extensive trip.

Prof. R. D. Bennett, of the Massachusetts Institute of Technology, has planned with Dr. Compton the world-wide survey which is being supported by the Carnegie Institution of Washington.—*Science Service*.



Fig. 12. A case of nodular liver, following the removal of an eye for melanoma. Note the areas of lessened density in the liver shadow.

node, composed of irregular, tubular glands, and a delicate, fibrillar stroma containing a few isolated glomeruli. Outside of the metastasis, the renal parenchyma was well preserved. In the stroma were a few flat and branched cells, filled by light gray crystals.

Peripancreatic Lymph Node.—This was completely replaced by glandular tumor tissue with focal areas of degeneration. Cells containing pigment were not found.

Peri-aortic Node.—Only a few small islands of lymphatic tissue were seen in the periphery of the glands, the remaining part being composed of tumor tissue.

Local Recurrence of Tumor in Ileum.—Irregular tubular glands, lined by low cylindrical, darkly nucleated epithelium, were separated by a finely fibrillar and cellular stroma. There were many foci of necrosis with karyorrhexis.

Brain.—The meninges showed a slightly increased cellularity. Pigmented cells could not be found.

We also used thorotrast with good results, in a case of splenomyelogenous leukemia to demonstrate the size of the spleen. The thorotrast caused no changes in the white blood count of this patient nor was there any change in the size of the spleen six months after injection. This patient was injected as an ambulatory case, without the slightest reaction. At present, although he still has symptoms of leukemia, apparently none is the result of thorotrast.

The third case presented palpable tumors in the abdomen, one of which was thought to be the spleen. This patient was injected with thorotrast, which showed the palpable tumor was not the spleen, since the latter was not enlarged.

The fourth case was rather obscure except for an enlargement of the liver which was thought to be metastatic, of obscure origin. Thorotrast showed the liver enlarged but with no metastases.

The fifth case was that of a very large nodular liver that followed the removal of an eye for melanoma. Figure 12 shows the enormous size of the liver, which was successfully visualized with 50 c.c. of thorotrast. The patient suffered no reaction during or after the injections.

The indication for the use of thorotrast is still in doubt, yet the author feels that it can be used safely in cases in which one expects to see gross changes in the liver and spleen. The sizes of these organs can be determined either by palpation or pneumoperitoneum, so that, in many conditions, it will add nothing to the older methods. In the following conditions it should be valuable: Primary and secondary carcinoma and sarcoma; adenoma; angioma; actinomycosis; hydatid disease (echinococcus).

In splenic conditions, it will be valuable in infarcts and especially thrombosis of the splenic artery. The latter is seldom diagnosed during life.

We feel that the contra-indications would

Workmen's Compensation Act is a bar to action for malpractice against physician.—[Revell vs. McCaughan (Tenn.), 39 S.W.R. (2nd) 269.] Revell instituted proceedings against his employer and his employer's insurer to recover compensation under the Tennessee workmen's compensation act. He averred that because of an industrial accident his index finger and the first joint of the little finger of his right hand had to be amputated and that because of blood poisoning that occurred as a complication he permanently lost entirely the use of his right hand and right arm. He was awarded compensation. Thereafter he brought this action, charging with malpractice the defendant, the physician who at the instance of his employer treated him when he was injured. Revell admitted that the injury to his finger was the result of the accident. In this action, however, he claimed that the loss of the use of his arm, the pain, and his other injuries were due to the defendant's malpractice. The defendant-physician pleaded that the settlement by the employer in the previous proceedings barred this action by the employee, Revell. The trial court thereupon dismissed the suit and Revell appealed to the Supreme Court of Tennessee.

It appears, said the Supreme Court, that the injuries for which the greater part of the compensation under the workmen's compensation act was awarded were due to the negligence of the physician. They were, therefore, injuries creating in a person other than the employer—namely, the physician—a legal liability to pay damages. Under such circumstances the workmen's compensation act gave Revell the option of claiming compensation from his employer under the act, or of proceeding at law against the person immediately responsible for his injuries, the physician, or of proceeding at law against both his employer and his physician. The workmen's compensation act, however, ex-

pressly provides that a workman situated as Revell was shall not be entitled to collect damages both from his employer and from the third person immediately responsible for his injuries, but that "if compensation is awarded under this Act the employer having paid the compensation or having become liable therefor may collect, in his own name or in the name of the injured employee in a suit brought for the purpose, from the other person in whom legal liability for damages exists, the indemnity paid or payable to the injured employee."—Pub. Acts, 1919, c. 123.

Revell, having elected to proceed under the workmen's compensation act and having been awarded compensation, was, therefore, barred from obtaining damages from the physician.

Revell contended, however, that the settlement with his employer could not have included his claim against the physician, citing in support of his contention *Quinn vs. Railroad*, 94 Tenn. 713, 30 S.W.R. 1036, in which it was held that an employer who has used reasonable care in the selection of a physician is not liable to his employee for injuries resulting from the negligence of that physician. That case, however, said the court, held that since the physician did not act under the direction and control of the employer, the physician could not be regarded as the employer's agent and that the employer was, therefore, not responsible for the physician's acts. If one is injured by the negligence of another and his injuries are aggravated by the negligence of a physician, the negligence of the original wrongdoer that made the services of the physician necessary is regarded as the proximate cause of the damage resulting from the physician's negligence. That is true even though the physician is selected by the injured person himself, provided the injured person exercises due care in making his choice. *Even*

Selected by I. S. TROSTLER, M.D., CHICAGO

Examining physician is agent of employer; therefore, injury produced during examination is not actionable as malpractice, but is for bodily injury against physician's employer.—[New York Central Railroad Co. vs. Wiler (Ohio), 177 N.E.R. 205.] Wiler, employed as a locomotive fireman by the New York Central Railroad Company, was directed to submit to an examination by the company's physician, so that the company might know his physical condition. He complied. Later he sued the company, alleging that its physician, while he was feeling with his fingers under and around Wiler's left groin, used unusual and unnecessary force and thereby caused a hernia. To Wiler's petition, the company filed a demurrer, which the trial court sustained. On appeal, however, the Court of Appeals, Lucas County, reversed that judgment and remanded the cause for further proceedings. Thereupon, the company appealed to the Supreme Court of Ohio.

On behalf of the company it was contended that when a railroad company employs a physician to render any service for it and for its own purpose, which service that physician in his professional capacity might render to a patient for the patient's own purpose, the duty of the railroad company ends with the exercise of reasonable care in the selection of the physician. In support of this contention, the company relied on a decision by the Supreme Court of Ohio, in Youngstown Park & Falls Street Ry. Co. vs. Kessler, 84 Ohio St. 74, 95 N.E. 509, which arose out of the treatment of Kessler by the company's physician for an injury received by Kessler in alighting from one of the company's cars. The purpose of the treatment in that case, however, said the Supreme Court, was to cure Kessler's injury.

It was directly for the benefit of Kessler. If it was for the benefit of the company at all, it was only indirectly so, in mitigation of the damages it might be required to pay for causing the injury. That situation, the court held, created the relationship of physician and patient between Kessler and the company's physician. The fact that the company assumed the obligation to compensate the physician for the service he rendered did not alter that relation.

But in the present case, said the Supreme Court, the purpose of the examination was not to treat or cure Wiler, an employee of the appellant railroad company. It was to inform the company of his physical condition, so as to enable it intelligently to determine whether it could safely and profitably continue him as one of its employees. The examination was for the benefit of the company, and not for the benefit of the employee. Under such circumstances, the relationship between the company and its examining physician was that of master and servant, unqualified by the circumstance that the servant was as a matter of fact a physician. *The action, therefore, was not an action for malpractice and subject to the statute governing the limitation of actions for malpractice. It was an action for bodily injury and the time within which action might be brought was determinable by the statute relating to actions for bodily injuries.*

The judgment of the Court of Appeals remanding the cause to the trial court for further proceedings was affirmed.¹

Note.—This might just as well, and should, apply to a roentgen examination and a roentgen injury. (Italics mine.)—I. S. T.

Election to proceed, and award under

¹Reprinted by permission from the Journal of the American Medical Association.

EDITORIAL

LEON J. MENVILLE, M.D. *Editor*
BUNDY ALLEN, M.D. *Associate Editor*

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Radiological Society of North America.*

HOSPITAL RADIOLOGIC DEPARTMENTS

The day is approaching when every hospital in the United States will have a well equipped radiologic department, conducted by a recognized radiologist. The rapid progress of radiology and its recognition by the medical profession as of the greatest importance in the diagnosis and treatment of disease will be the means, in time, of compelling all hospitals to be adequately equipped with modern X-ray apparatus and with sufficient radium to treat any case. The control of these agencies will be placed in the hands of a competent and experienced radiologist. It may even come to pass that it will be unlawful for any hospital to admit patients unless the hospital meets with certain requirements in regard to laboratory facilities. A physician is required by law to submit to examination by a medical examining board before he can practise his profession: thus the State protects its citizens from quacks and incompetent physicians. Why, then, should not these same citizens be protected by law against hospitals which disregard the welfare of their patients by not having the essential necessities for the practice of modern medicine?

We find, from a recent report by the American Medical Association, that roentgen-ray departments of hospitals are on the increase. "From 2,841 roentgen-ray de-

partments in 1923 to 4,615 at the present time, or an increase of 62 per cent in eight years, is the record which hospitals have set. The State of New York, which reported 242 roentgen-ray departments eight years ago, now has 401. Large increases are registered in Florida, Kentucky, New Hampshire, Oklahoma, South Carolina, Utah, Vermont, and Virginia, each of which has a growth of 100 per cent or more over the number of roentgen-ray departments reported in 1923. Through the inspection of hospitals and correspondence with those which are not inspected, we are able to know that the hospitals which had not already made arrangements to have the roentgen-ray work supervised by competent physician-radiologists are rapidly establishing such service."

There are at present 1,998 hospitals in the United States without radiologic departments. It is inconceivable that such institutions, wholly devoted to the care of the sick, can be so derelict in their obligation to the public as to fail to provide adequate laboratory facilities. Without such provision, it is impossible for any hospital to operate effectively. In fact, it is just as incredible for a hospital to function efficiently without a radiologic department as for a physician to practise medicine without a stethoscope, thermometer, and blood-pressure apparatus. Yet there are physicians who do not hesitate to send their patients to such a hospital, depriving the helpless sick of a diagnostic and therapeutic aid to which they are entitled. It would appear that physicians are principally concerned with the presence of operating room facilities—nothing else seems to matter. It also happens

if the plaintiff in this case had sued his employer at law, instead of proceeding under the workmen's compensation act, the employer would still have been liable for the result of the medical treatment.

The judgment of the trial court in favor of the physician-defendant was affirmed.¹ (Italics mine.)—I. S. T.

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THE COMING ANNUAL MEETING

Time.—Monday, November 28, 1932, to Friday, December 2, 1932.

Place.—Atlantic City, New Jersey; Hotel Haddon Hall. Do not delay in writing for reservations.

Scientific Exhibit.—The plan is to display this in the ballroom on the second floor, where the illuminating boxes can be so spread out as to allow ample space between exhibits. Also, there will be space for chairs, so that it will be natural for groups to form for discussion of the exhibits while seated at their ease, rather than to have to stand in close proximity to the viewing boxes. The Scientific Exhibit naturally forms a nucleus for group discussion, and the officers have had in mind that space and comfort are factors in its success. Dr. J. T. Farrell, Jr., 235 South 15th Street, Philadelphia, is Chairman.

Commercial Exhibit.—This will be on the same floor as one of the excellent section meeting rooms, the thirteenth. This space is well adapted to its purpose, the Committee having had in mind the convenience of exhibitors and accessibility to visitors. Dr. A. L. L. Bell, 340 Henry Street, Brooklyn, N. Y., is in charge of arrangements.

Section Meeting Rooms.—One of these is on the thirteenth floor, near the Commercial Exhibit, while another is on the first floor. They are excellent rooms from every viewpoint.

Transportation.—If one hundred round-trip railroad tickets are validated, a rate of a fare and a half will be allowed, as in previous years. While plans are being perfected for a good attendance, it is not unlikely that many Eastern men will motor to

Atlantic City, thus reducing the number of railroad tickets purchased. While this would seem to impose a hardship on those from a distance who will naturally come by rail, it is a logical consequence and one which it is quite useless to deplore. Of course, it is highly desirable that there shall be enough visitors to guarantee reduced rail rates, while those living nearby are enabled to avail themselves of a pleasant motor trip.

When purchasing your railroad tickets, therefore, if you come that way, ask for certificates as in the past, yet be canny enough to bring along enough money for full-fare return tickets in case so many of your associates motor to the meeting as to render this necessary.

Weather.—Visitors from a distance, who expect Atlantic gales to sweep Atlantic City's board walk, are respectfully referred by the officers to Dr. William G. Wescott, who is a resident of Atlantic City and "as convinced of its climatic perfection as are Californians of that of the West Coast."

Geographical Location.—Visitors will be within short rides of New York City, Philadelphia, Washington, and Baltimore, with their wealth of medical centers and institutions. A trip to the Atlantic City meeting may well embrace visits you have long wanted to make in the East.

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sion at nearly every annual meeting of our Society, yet nothing has been done about it.

The American Medical Association is deserving of much credit and praise for its efforts to standardize radiologic departments in hospitals. They were among the first to recognize radiology as of sufficient importance to a hospital to warrant the setting down of definite regulations concerning radiologic departments. The Association will not register any hospital which fails to comply with the following regulation:

"The hospital should provide or have ready access to radiologic equipment and service. When a full-time or part-time physician-roentgenologist cannot be employed, the services of such a consultant should be procured. Radiologic interpretations must be made only by a competent roentgenologist. A description of the roentgenologic examinations should be placed in the patient's chart. The physician-roentgenologist preferably should be one listed by the Council on Medical Education and Hospitals of the American Medical Association."

We are not unappreciative of the great work of the American Medical Association in standardizing radiology in hospitals, yet we cannot help feeling that greater good would be accomplished if representative radiologists were invited by the Association to participate in hospital inspection. They might well be permitted to offer suggestions, based on their years of experience, in the choice of equipment for the radiologic department and also as to the ability and experience of the radiologist placed in charge.

It is reported that the radiologic departments of some of our state, county, and city hospitals are being severely abused. Many of the increasing numbers of patients now being admitted in these institutions are capable of paying private fees. On account of the laxity prevailing, there results an influx of free patients. In fact, there has been an

increase in these various kinds of hospitals with a large additional bed capacity, during the last few years. This is demonstrated in a report recently published by the American Medical Association based on its investigation into the present hospital situation in the United States.

The American Medical Association reports that in 1932 there were 6,613 hospitals with 974,115 beds. Of this number, 576 were state hospitals; 508, county, and 77, city and county, a total of 1,525 hospitals under the control of state, county, and city governments. In 1927 there were 1,508 such hospitals, 17 less than at the present report of the American Medical Association. In 1927, these 1,508 hospitals had 484,725 beds, and in 1931, this number had increased to 572,354, an increase in four years of 87,629 beds. This large increase in hospital beds during the short period of four years is deserving of serious consideration and in a large measure accounts for the presence of "Old Man Depression" among the ranks of the medical profession. It is reasonable to believe that nearly all the patients occupying beds in these institutions are regarded as free patients, because these institutions are maintained by state and local governments. We are unable to find at this time how many of these 1,525 hospitals have radiologic departments, but, because they are maintained by public funds we may assume that nearly all of them have such departments and many free roentgen-ray examinations and radium treatments are made.

The large number of charity patients admitted to hospitals supported by the public can in part be attributed to the depression, but in a measure this increase is the result of the desire on the part of the public to obtain anything that is free. In one of these hospitals, there has been an increase of 42 per cent in the charity patients treated during the last three years. In times such as these, people are panic-stricken and become

frequently that physicians refer patients to a hospital which has some X-ray apparatus, depending upon a lay technician to interpret the roentgen findings and to direct the application of radiation therapy. In certain instances, they make their own interpretations.

There seems to be a lack of understanding on the part of some physicians as to what constitutes a modern hospital's radiologic department. Their understanding is that somewhere in the hospital is a place in which photographs are made of their patients. There is supposed to be an X-ray photographic machine so simplified and so constructed that it is necessary only to push a switch and the "picture" comes out, so clear that little difficulty is experienced in making a diagnosis by almost anyone with slight experience. What a marvel! Apparently they fail to understand that the responsibility lies not in making the so-called "photograph" or "picture" but in its interpretation by a competent physician-roentgenologist.

We often hear of the business executive of a hospital inviting the medical and surgical staffs to inspect newly purchased X-ray apparatus. Someone expatiates on the grandeur and the great power of the apparatus, which is capable of making roentgenograms of "all parts of the body." The speaker is particularly solicitous in impressing the staff with the fact that the hospital has an X-ray laboratory, modern in every respect. Nothing is said perhaps as to whether or not this equipment is capable of handling the volume of work demanded by the hospital; nor is anything said as to the ability and experience of the one who is to operate this costly apparatus. In fact, the mere operating of the laboratory is oftentimes considered a trivial matter and for this reason but little consideration is given to it. In this regard, it is timely to warn hospital authorities of the care they should exercise in purchasing X-ray apparatus. Recently

an eminent electrical engineer¹ said: "Manufacturers have at times been at fault when designing equipment in keeping in mind a low competitive sales price rather than the utility and safety of the product. This practice has been encouraged by some laymen hospital boards which purchase X-ray equipment on price basis only. This is due to their lack of intimate knowledge of uses and details of equipment, and of types of installation. Correction for this is suggested by giving the roentgenologist final approval on purchases made for hospital use."

In rural districts some ambitious but misguided physician assumes the rôle of surgeon, opens to the public a few rooms with perhaps some X-ray equipment, and calls this a hospital. It can be appreciated that under such circumstances it would be impossible to secure the services of an experienced radiologist to conduct this so-called radiologic laboratory. But, in such instances, the physician becomes his own radiologist. We do not subscribe to this sort of practice, which is bad, but perhaps under the circumstances, it may be permissible, particularly if the main use of the roentgen rays is in cases of fractures and dislocations. There can be no excuse, however, for any hospital in a large medical center, where it is always possible to procure the services of eminent radiologists as consultants, to continue to have inefficient, incompetent, and inexperienced physicians or lay technicians assume the responsibility of a radiologist. It is time for the radiological societies to manifest a greater interest in this regard. That this subject is of vital interest to all of us is shown by resolutions passed at the last meeting of the Radiological Section of the Southern Medical Association in regard to investigating the present hospital situation. The subject is brought up for discus-

¹W. S. Werner: X-ray Protection from the Manufacturer's Viewpoint. *RADIOLOGY*, July, 1932, XIX, 5, 6.

used tobacco, the moment an irritated spot appeared, the dentist would recognize it in time and have the use of tobacco stopped.

"Up to 1900 in Halsted's clinic at Johns Hopkins, in the first hundred cases, the incidence of cancer was more than 80 per cent; benign tumors were less than 20 per cent. Among the 80 per cent more than one-half were inoperable. Among the operable cases the chances of a five-year cure were less than 20 per cent, of ten-year cures less than 10 per cent. Until 1900; no woman came for examination of the breast without a definite tumor for which operation was performed. In my clinic to-day the incidence of cancer is less than 10 per cent; the group of benign lesions for which operation is not indicated has now reached almost 80 per cent. The majority of these thousand women whose breasts were examined in the course of a physical examination, or because they had had recent warning symptoms, are mothers, and there should be a pelvic examination, especially an inspection of the cervix, by a good light. The skin should be surveyed for definite lesions. The mouth, nasopharynx, and nose should be looked at, and there should be a rapid diagnostic survey with a few laboratory studies. Should the general practitioner educate himself and prepare a proper examining room in his office for these diagnostic surveys, and the health departments, in co-operation with the local county, city, or state medical societies, educate and influence the public to seek these examinations, the average physician would have more to do than when there was no health department and no preventive medicine. It is to be borne in mind that these periodic physical examinations and diagnostic surveys are not for cancer only, but the threat, the scourge, the possibility of cancer as a disease of neglect, allows the medical profession and the health departments to employ it in influencing the public in regard to the necessity of selecting a clin-

ic, or physician, or hospital while one is well and submitting to a periodic examination at proper intervals, and a diagnostic survey the moment one is warned. . . .

"We know that fully developed cancer, even with involved neighboring glands, has remained well twenty or more years after a proper complete operation. This is true of cancer of the skin, lip, and oral cavity, larynx, breast, stomach, colon, and rectum; malignant tumors of bones and soft parts. This group includes the most accessible to surgery. To-day there are twenty-year cases of cancer after the employment of roentgen rays and radium. Hence the control of cancer is no longer an experiment. All the various activities of which the world has been kept pretty well informed have passed the experimental stage. Of course, there is much still to be done in clinical research, especially in relation to deep roentgen-ray therapy and the amount and method of radium treatment for early cases of cancer of the cervix, skin, and oral cavity. There is still hope that, by increasing the amount of radium in the form of a bomb to 15 gm. and increasing the strength of the deep roentgen-ray machine, we may accomplish a certain percentage of successes in what are not uniform failures, that is, late cases of cancer, metastatic carcinoma, and localized early inaccessible cancer, such as in the esophagus, lung, and liver, and the early stages of cancer of the prostate, of which there is a very large number of cases. There is remaining the most important effort to be carried forward in pure research into the cause of cancer and the specific and preventive treatment of the disease. . . .

"Even if every individual submits to an annual diagnostic survey, complete protection is not achieved until the individual is informed and influenced to seek the advice, the moment he has any warning symptoms, of the nearest clinic if he is near one or the

hysterical, and when sickness overtakes them they immediately apply to free institutions. Too often those admitted as free patients are well able to pay for private medical and radiologic services, and are permitted to occupy beds and receive free roentgen-ray examinations and radium treatments and other hospital facilities which rightfully belong only to poor and indigent patients. Also, physicians have been known to send their private patients for free roentgen-ray examinations and radium treatments in these government-controlled hospitals. In such instances, it must be appreciated that the physician cannot be accused of being derelict in collecting his fee. In certain localities it is reported that compensation insurance companies send many of their cases to these institutions, where a nominal charge is made for services rendered. These abuses should cease. Not only is it unfair to the medical profession, but also to the taxpayers, who are made to carry the burden of expenses in maintaining these government-controlled hospitals.

THE CANCER PROBLEM

We are in receipt of a lengthy communication from Dr. Joseph Colt Bloodgood, noted cancer authority, in regard to the present cancer situation. It is to be recalled that Dr. Bloodgood has recently returned from a European lecture tour. His visit to Europe was by invitation of some of the leading cancer authorities there, to present the newer developments and conceptions in the diagnosis and treatment of cancer from the American viewpoint. Dr. Bloodgood's extensive experience in cancer work, and his profound knowledge of this subject, no doubt were the reasons for his being selected by the European physicians to discuss with them the present cancer situation.

RADIOLOGY expresses its regret in not

having sufficient space to publish in full Dr. Bloodgood's recent contribution in regard to the chief controllable factor in cancer to-day. The article contains so much valuable and pertinent information for all of us that we will present a few paragraphs in order that our readers may appreciate the tremendous importance of this contribution.

"I have personally studied thousands of histories of patients who sought the advice of the medical profession after they had been warned for some time. The striking facts in these histories are: These patients, whose malignant disease can be diagnosed clinically, either have no family physician, even if they could afford it, or they have not had a recent diagnostic survey, and the chief cause of delay after they become aware of their symptoms has been ignorance rather than fear. From the very beginning of my contact with people suffering from cancer, forty years ago, I have been impressed that those who came early in those days had family physicians in whom they had confidence, and whom they consulted the moment they had any symptoms. The outstanding fact of the people operated on for cancer, whose histories are reported in the Surgical Pathological Laboratories of the Johns Hopkins University and Hospital, and who are alive and free from recurrence to-day, from ten to thirty years after operation, was that they all had a well trained family physician whom they consulted at intervals while they were well and always at once when they were not. From the very beginning of my studies of cancer of the oral cavity, the outstanding feature of the history was that the patient had not seen a physician for years, if at all. I am rather inclined to the opinion that the dental profession to-day could almost guarantee protection against cancer if their patients would submit to an oral examination as frequently as the dentists think necessary. In this way all irritation from teeth and plates would be eliminated. If the patient

tickets, secure a certificate—it may save you a tidy sum on the way home.

The above tabulation of railroad fares and Pullman charges has been prepared under the supervision of A. L. L. Bell, M.D., of Brooklyn, N. Y., Chairman of Transportation for the Society. It may prove of interest to those who are preparing to go to the Atlantic City meeting.

"A CENTURY OF PROGRESS" EXHIBIT

The Mallinckrodt Chemical Works, of St. Louis, in addition to a commercial display, is sponsoring an exhibit in the electrochemical section of the chemistry division at the Century of Progress, Chicago, in 1933. This exhibit, which has already been constructed, shows the growth and development of metallic crystals of lead, tin, and cadmium. It is now in the Basic Science laboratory in the Administration Building, pending its removal to the Great Hall of Science, where it will be on permanent display during the exposition. The Hall of Science was recently completed and dedicated, but, as yet, none of the permanent displays have been removed to it. The Administration Building, where the Mallinckrodt exhibition is at present situated, is open to the public and visitors are cordially invited to inspect the various displays.

nisse der Medizinischen Strahlenforschung," Vol. IV, has been reprinted in monograph form. It is a comprehensive treatise of a phase of gastro-intestinal roentgenology which offers many perplexing problems for the roentgenologist. The author first discusses the physiologic changes resulting from operations on the stomach, and the roentgenologic technic for examining the post-operative stomach. In Chapter IV the roentgenologic features of the various types of gastric operations are discussed in detail, as follows: (a) Gastrotomy, local incision, closure of perforations and gastroplastics; (b) Gastrostomy and gastro-gastrostomy; (c) Stomach and bowel anastomoses (1) gastrojejunostomy, (2) gastroduodenostomy, (3) duodenojejunostomy; (d) Alteration of pyloric function (1) pyloroplasty, (2) pyloric occlusion by Eiselberg's method; (e) Gastric resections (1) sleeve resection, (2) Billroth No. 1, (3) Billroth No. 2, (4) subtotal and total resection, stomach and colon resection; (f) Gastropexy. In Chapter V the following post-operative complications are considered: (a) Operative and mechanical conditions (1) peritonitis, (2) subphrenic abscess, (3) adhesions, (4) abdominal hernia, (5) internal hernia; (b) Spastic and atonic complications; (c) Late complications (1) non-healing ulcerations, (2) gastrojejunal ulcer and gastrocolic fistula.

This book should be of great interest to all roentgenologists and gastro-enterologists for it contains much information that is pertinent to a very important subject. The text is fully illustrated by 146 excellent roentgenograms and drawings.

BOOK REVIEWS

DER OPERIERTE MAGEN. By PROF. DR. HERMANN MEYER-BURGDORFF and DR. WALTER SCHMIDT, Göttingen. A volume of 114 pages and 146 illustrations. Published by Georg Thieme, Leipzig, Germany, 1930. Price, 9.60 marks.

This study of the roentgenologic appearance of the post-operative stomach which previously appeared as a chapter in "Ergeb-

EINE METHODE ZUR MESSUNG VON RÖNTGEN-, RADIUM-, UND ULTRA STRAHLUNG NEBST EINIGE UNTERSUCHUNGEN ÜBER DIE ANWENDBARKEIT DERSELBEN IN DER PHYSIK UND DER MEDIZIN. Mitt einem Anhang enthaltend einige Formeln und Tabellen für die Berechnung der Intensitätsverteilung bei gamma-Strahlungsquellen. By ROLF M. SIEVERT, from the Physical Laboratory of the Radiumhemmet, Stockholm. Supple-

physician who made the last physical examination."¹

The subject of cancer is one that is always considered important. We are constantly benefiting by the experience of others, through a clearer understanding of this subject, until, at present, the disease is more amenable to treatment than ever before. It must be appreciated, as Dr. Bloodgood so correctly stated, that the early recognition of the disease cancer is the most effective factor in successfully treating it. We must, therefore, become more interested in cancer education, which will do more in focusing the attention of the laity upon the need for periodic examinations than anything we know.

ANNOUNCEMENTS

SOUTH CAROLINA X-RAY SOCIETY

On June 9, 1932, at a meeting held in the Medical Building, Columbia, South Carolina, the roentgenologists of the State of South Carolina formed the South Carolina X-ray Society.

The following physicians were made charter members: F. D. Rogers, M.D., of Columbia; R. B. Taft, M.D., of Charleston; P. D. Hay, M.D., of Florence; O. D. Baxter, M.D., of Sumter; Hillyer Rudisill, M.D., of Charleston; W. S. Judy, M.D., of Greenville; T. A. Pitts, M.D., of Columbia; W. M. Sheridan, M.D., of Spartanburg; F. R. Wrenn, M.D., of Anderson, and M. Mosteller, M.D., of Columbia.

F. D. Rogers, M.D., of Columbia, was elected President and Robert B. Taft, M.D., of Charleston, Secretary.

Meetings will be held at the time and place of the South Carolina State Medical

Association meeting. The next one will be in Spartanburg in April, 1933.

THE COMING ANNUAL MEETING

ONE-WAY FARES AND PULLMAN CHARGES TO ATLANTIC CITY

From	Fare	Pullman ¹
Albany, N. Y.....	\$ 10.06	\$ 3.00 (to New York) 1.13 ² (to New York)
Atlanta, Ga.	29.93	8.63 ³
Boston, Mass.	13.19	2.63 ²
Buffalo, N. Y.....	17.04	4.50
Chicago, Ill.	31.52	9.00
Cleveland, O.	19.37	5.63
Dallas, Texas	57.38	17.25 ³
Denver, Colo.	68.80	19.13 ³
El Paso, Texas.....	80.68	23.63 ³
Houston, Texas	60.78	17.25 ³
Kansas City, Mo.....	46.92	12.75 ³
Los Angeles, Cal.....	108.59	31.50 ³
New Orleans, La.....	47.16	13.50 ³
New York, N. Y.....	4.93	1.13 ²
Omaha, Nebr.	49.45	12.75 ³
Philadelphia, Pa.....	2.06	.50 ²
Pittsburgh, Pa.	14.64	4.50
Portland, Ore.	108.73	31.50 ³
St. Louis, Mo.....	36.88	10.88
St. Paul, Minn.....	45.79	12.00 ³
Salt Lake City, Utah	86.59	23.63 ³
San Francisco, Cal....	108.59	31.50 ³
Seattle, Wash.	108.73	31.50 ³
Tampa, Fla.	42.97	12.75 ³
Washington, D. C....	7.32	3.75 1.50 ²

Bear in mind that these are one-way fares. If one hundred railroad tickets are validated, all will be able to avail themselves of the half-fare return trip. In buying

¹Pullman charges are for lower berth and include surcharge.

²Seat charge

³Through Pullman charge to Philadelphia Seat charge from there to Atlantic City, 50 cents additional

tickets, secure a certificate—it may save you a tidy sum on the way home.

The above tabulation of railroad fares and Pullman charges has been prepared under the supervision of A. L. L. Bell, M.D., of Brooklyn, N. Y., Chairman of Transportation for the Society. It may prove of interest to those who are preparing to go to the Atlantic City meeting.

"A CENTURY OF PROGRESS" EXHIBIT

The Mallinckrodt Chemical Works, of St. Louis, in addition to a commercial display, is sponsoring an exhibit in the electrochemical section of the chemistry division at the Century of Progress, Chicago, in 1933. This exhibit, which has already been constructed, shows the growth and development of metallic crystals of lead, tin, and cadmium. It is now in the Basic Science laboratory in the Administration Building, pending its removal to the Great Hall of Science, where it will be on permanent display during the exposition. The Hall of Science was recently completed and dedicated, but, as yet, none of the permanent displays have been removed to it. The Administration Building, where the Mallinckrodt exhibition is at present situated, is open to the public and visitors are cordially invited to inspect the various displays.

nisse der Medizinischen Strahlenforschung," Vol. IV, has been reprinted in monograph form. It is a comprehensive treatise of a phase of gastro-intestinal roentgenology which offers many perplexing problems for the roentgenologist. The author first discusses the physiologic changes resulting from operations on the stomach, and the roentgenologic technic for examining the post-operative stomach. In Chapter IV the roentgenologic features of the various types of gastric operations are discussed in detail, as follows: (*a*) Gastrotomy, local incision, closure of perforations and gastroplasties; (*b*) Gastrostomy and gastro-gastrotomy; (*c*) Stomach and bowel anastomoses (1) gastrojejunostomy, (2) gastroduodenostomy, (3) duodenojejunostomy; (*d*) Alteration of pyloric function (1) pyloroplasty, (2) pyloric occlusion by Eiselberg's method; (*e*) Gastric resections (1) sleeve resection, (2) Billroth No. 1, (3) Billroth No. 2, (4) subtotal and total resection, stomach and colon resection; (*f*) Gastropexy. In Chapter V the following post-operative complications are considered: (*a*) Operative and mechanical conditions (1) peritonitis, (2) subphrenic abscess, (3) adhesions, (4) abdominal hernia, (5) internal hernia; (*b*) Spastic and atonic complications; (*c*) Late complications (1) non-healing ulcerations, (2) gastrojejunal ulcer and gastrocolic fistula.

This book should be of great interest to all roentgenologists and gastro-enterologists for it contains much information that is pertinent to a very important subject. The text is fully illustrated by 146 excellent roentgenograms and drawings.

BOOK REVIEWS

DER OPERIERTE MAGEN. By PROF. DR. HERMANN MEYER-BURGDORFF and DR. WALTER SCHMIDT, Göttingen. A volume of 114 pages and 146 illustrations. Published by Georg Thieme, Leipzig, Germany, 1930. Price, 9.60 marks.

This study of the roentgenologic appearance of the post-operative stomach which previously appeared as a chapter in "Ergeb-

EINE METHODE ZUR MESSUNG VON RÖNTGEN-, RADIUM-, UND ULTRA STRAHLUNG NEBST EINIGE UNTERSUCHUNGEN ÜBER DIE ANWENDBARKEIT DERSELBEN IN DER PHYSIK UND DER MEDIZIN. Mitt einem Anhang enthaltend einige Formeln und Tabellen für die Berechnung der Intensitätsverteilung bei gamma-Strahlungsquellen. By ROLF M. SIEVERT, from the Physical Laboratory of the Radiumhemmet, Stockholm. Supple-

ment 14 to *Acta Radiologica*, paper, 179 pages, with 142 tables and 171 figures in the text followed by 22 pages of formulas and tables and 8 pages of reproductions of photographs. F. Englands Boktryckeri A. B., Stockholm, 1932. Price, 20 Swedish crowns.

In this monograph Sievert first goes into a thorough discussion of the mathematics and physics of ionization measuring devices. From these considerations he favors condenser-chamber systems, the advantages and disadvantages of which are analyzed. He has developed many condenser-chamber measuring devices which are suitable not only for measuring the various types of X-rays, but also gamma rays, so that the technical factors used in radiotherapeutic technics can be checked up not only at the Radiumhemmet, but also can be compared with those factors used in clinics elsewhere. Sievert then describes and illustrates some condenser-chamber devices which he has used for measuring not only surface doses but those in the body cavities. By the use of these ingenious chambers it is easy to measure the "dose" on the side of the neck opposite to that on which the radiation is incident. The peculiarities of the physics and the construction of these chambers is considered from a point of view understandable by any one who has studied high-school mathematics and physics.

The monograph has a bibliography of 171 references to ionization studies, then photographs of the measuring devices and their accessories, and closes with tables of the energy distribution of gamma radiation.

The reviewer hopes this book will shortly appear in English as it is the best on the subject of which he personally has knowledge.

E. T. LEDDY, M.D.

A STUDY OF THE IONIZATION METHOD FOR MEASURING THE INTENSITY AND ABSORPTION OF ROENTGEN RAYS AND OF THE EFFICIENCY OF DIFFERENT FILTERS USED IN THERAPY. By ROBERT THORAEUS, from the Physical Laboratory of the Radiumhemmet, Stockholm. Supplement 15 to *Acta Radiologica*. Paper, 88 pages with 40 figures

and 23 tables in the text. F. Englands Boktrycker, Stockholm, 1932. Price, 10 Swedish crowns.

In this monograph Thoraeus reports some measurements he carried out at the Radiumhemmet with a constant potential roentgen machine by means of a standard and a portable ionization apparatus. Five qualities of radiation were used: (a) 1 mm. aluminum and 100 K.V. const.; (b) 2 mm. aluminum and 100 K.V. const.; (c) 4 mm. aluminum and 140-150 K.V. const.; (d) 0.5 copper + 1 mm. aluminum and 165-175 K.V. const.; (e) combined tin filter and 165-175 K.V. constant. With these set-ups the filtering properties of different metals were studied and are given in numerous charts and tables. The efficiency of various metals as filters is discussed and data are given by which the best filter may be selected. The author describes a new tin filter to take the place of 2 or 3 mm. copper to produce hard radiation, and points out its advantages.

The monograph closes with some studies made in the water phantom on the relative rôles of true absorption and back-scattering.

This little book is to be recommended as a masterful contribution toward solving the puzzling problems of filtration and dosage in roentgentherapy.

E. T. LEDDY, M.D.

BIOLOGIE DES RADIUM UND DER RADIOAKTIVEN ELEMENTE. By JULIUS STOKLASA, PH. DR., DR. ING. H. C. DIPL. ING. AGR., Professor der Tschechischen Hochschule, Direktor der Staatlichen Versuchsstationen und Mitglied des Wissenschaftlichen Kuratoriums des Staatlichen Radiologischen Instituts in Prag, and JOSEF PENKAVA, DR. ING. Sektionsrat und Wissenschaftlicher Mitarbeiter des Staatlichen Radiologischen Instituts in Prag. Volume I. Biologie des Radiums und Uraniums. Cloth, 958 pages, with 152 figures in the text, 1 colored plate, and 4 tables. Published by the support of the Tschechoslowakischen Ministeriums für Schulwesen und Volkskultur. Verlagen von Paul Parey, Berlin, 1932. Price, 74 Reichsmarks.

Stoklasa, the first president of the International Congress of radiologists and roentgenologists, held in Prague in 1912, has summed up in this book his twenty-five years' experience in the biology of the radio-active elements for all whose work lies in this field. The book will appear in two volumes; in the first there is discussed the radio-activity of the earth's atmosphere and earth's gases (pages 1-74), the lithosphere (pp. 75-138), the hydrosphere (pp. 139-174), the taking up of radio-active inductions by plants and animals (pp. 175-182), the historical development of research on the effect of radio-activity on micro-organisms, plants, and animals (pp. 183-198), the effect of the various radio-active elements on the metabolism of plants (pp. 199-214), the effect of the various radio-active elements on the animal and human bodies (pp. 215-253), the biology of uranium (pp. 254-319), the biology of the ionium-radium family (pp. 320-461), the chemistry of the sugars in the living plant cells and the effect of radio-activity on the anaërobic gas exchanges in the plant organism (pp. 462-508), cell respiration (pp. 509-539), the dynamics and the energy exchanges in the assimilation of carbonic acid (pp. 540-586), the assimilation of carbon dioxide as effected by radio-activity in the course of the vegetative development of chlorophyllous cells (pp. 586-617), the utilization of light in photosynthesis and its formative effect on the growth and reproduction of cells (pp. 618-639), the effect of radio-activity on the animal organism (pp. 640-645), the radiophysiology of animal cells (pp. 646-767), the physiology of metabolism (pp. 768-784), the effect of alpha, beta, and gamma radiation on the anaërobic respiration of animal organs (pp. 785-801), some experiments on the chemistry of anaërobic metabolism in the animal body under the effect of alpha, beta, and gamma radiation from radium (pp. 802-874), the effect of alpha, beta, and gamma radiation on the aërobic respiration of the animal organism (pp. 875-887), the effect of beta and gamma radiation on the growth of young animal structures (pp. 888-900), and concluding remarks (pp. 901-911).

A voluminous bibliography follows each chapter. An extensive index (pp. 912-957) closes the volume.

Even though this book is of little practical value to radiotherapists, its inclusion in their libraries is well worth while because it is a storehouse of information about material that may be capable of adaptation into clinical treatment and because it will give them a knowledge of the purely scientific basis on which radiotherapy rests. For biologists and researchers in the fields of physiology and of radio-activity, this work will be a welcome reference book.

E. T. LEDDY, M.D.

VERLAUF DER WICHTIGSTEN KNOCHEN- UND GELENKERKRANKUNGEN IM RÖNTGENBILDE. EINE ANSCHAULICHE PROGNOSTIK. By Privatdozent DR. MED. VICTOR HOFFMANN, Oberarzt der Chirurgischen Universitätsklinik im Augusta-Hospital zu Köln. With a German and English text. A volume of 264 pages and 585 illustrations. Published by Julius Springer, Berlin, 1931. Price, 69.80 reichmarks.

In presenting this volume the author has carried out an idea and fulfilled a purpose that subsequent authors of roentgenologic texts might well emulate. Hoffmann has concerned himself not only with the diagnosis but the subsequent progress of the various conditions that he presents. The latter phase of roentgenologic diagnosis has been much neglected. The majority of us concern ourselves with the original diagnosis, which is important, to be sure, but too few are familiar with the subsequent stages and end-results of disease. As the author states, the object of the book is to demonstrate the most important bone and joint diseases and their subsequent course. The various stages which are shown belong to one and the same case and are not the different stages of a disease in different patients. In this way the entire course is accurately presented in a way that is rarely possible to see in daily life except in a large clinic.

Chapter I concerns acute inflammation of bones and joints classified as (a) hematogenous, dental and traumatic osteomyelitis, and (b) acute specific and non-specific joint inflammation. The series of roentgenograms used to depict these various conditions are well chosen and extremely instructive. Chapter II is devoted to the chronic specific inflammations, tuberculosis, and hereditary and acquired syphilis of bones and joints. The various types of tuberculous bone infection are illustrated most excellently. Chapter III is devoted to a presentation of the primary and secondary bone tumors and the progressive course of these lesions is well depicted. In Chapter IV there is a discussion of disturbances of growth, classified as (a) primary growth interception, (b) secondary growth interception, (c) localized circulatory and growth disturbances, and (d) metabolic disturbances. Chapter V concerns chronic non-specific joint diseases considered as (a) chronic joint rheumatism, and (b) arthritic deformans and tabetic arthropathy. Chapter VI treats of the healing of fractures, pseudo-arthritis, epiphyseal injury, and intracapsular fracture. A supplement to this chapter concerns myositis ossificans, traumatic bone atrophy, and ischemic muscle contracture. The concluding chapter deals with bone transplantation and joint formation under the divisions (a) independent auto- and hetero-transplantation, and (b) arthroplasty and nearthrosis.

This volume is more than a pictorial atlas, as there is an excellent summary of the significant clinical phenomena associated with each case, and an introductory paragraph for each subject which contains the pertinent facts concerning it. Those who cannot read German will be grateful for the coexisting English translation of the text which undoubtedly will enhance the value of this work

in English-speaking countries. The publishers are to be complimented for the excellence of the illustrations, upon which the success of a volume of this sort depends.

COURTS AND DOCTORS. By LLOYD PAUL STRYKER. Fifth printing (in seven months); 236 pages, 12 mo, maroon buckram. Published by The Macmillan Company, New York, 1932. Price \$2.00.

The author was for many years the general attorney for the Medical Society of the State of New York and during that period had personal charge of the legal affairs of that body.

The book is replete with concise, desirable, and authoritative information presented in a readable manner. Unlike most books on law, this one is not dry and tiresome, but may be opened at any page and something of interest and value found.

The arrangement under the headings of The Practice of Medicine, The Relationship of Patient and Physician, The Action for Malpractice, Defenses to Action for Malpractice, Expert Testimony, The Doctor on the Witness Stand, and The Doctor and Criminal Law is good and this is further improved by division into thirty chapters upon different medico-legal subjects. Leading cases (279) are cited and tabulated as references and also alphabetically listed.

This book shows that the writer knows doctors, and knowing doctors as he does, he is better able to intelligently advise them. It is valuable and should be in the hands of every physician who has been sued, is being sued, or is liable to be sued; has been on the witness stand or expects to be a witness; visits patients or has patients visit him.

I. S. TROSTLER, M.D.

HOTEL RATES FOR ANNUAL MEETING

The following rates are quoted by the Atlantic City Convention and Publicity Bureau, Inc., as applying to the Chalfonte and Haddon Hall Hotels:

	American Plan (With Meals)				European Plan (Without Meals)			
Single Rooms with Bath.....	\$7	\$8	\$9	\$10	\$3	\$4	\$5	\$6
Double Rooms with Bath.....	\$12	\$14	\$16	\$18	\$5	\$6	\$7	\$10
Single Rooms, Running Water.....	\$5 (Chalfonte only)							
Double Rooms, Running Water.....	\$9 (Chalfonte only)							

ABSTRACTS OF CURRENT LITERATURE

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Ulcers (Etiology).....	335	Veneral Disease.....	336

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B. J. DeLaureal, M.D.
H. W. Hefke, M.D.
E. T. Leddy, M.D.

Davis H. Pardoll, M.D.
E. A. Pohle, M.D., Ph.D.
C. G. Sutherland, M.D.

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Chapter I concerns acute inflammation of bones and joints classified as (a) hematogenous, dental and traumatic osteomyelitis, and (b) acute specific and non-specific joint inflammation. The series of roentgenograms used to depict these various conditions are well chosen and extremely instructive. Chapter II is devoted to the chronic specific inflammations, tuberculosis, and hereditary and acquired syphilis of bones and joints. The various types of tuberculous bone infection are illustrated most excellently. Chapter III is devoted to a presentation of the primary and secondary bone tumors and the progressive course of these lesions is well depicted. In Chapter IV there is a discussion of disturbances of growth, classified as (a) primary growth interception, (b) secondary growth interception, (c) localized circulatory and growth disturbances, and (d) metabolic disturbances. Chapter V concerns chronic non-specific joint diseases considered as (a) chronic joint rheumatism, and (b) arthritic deformans and tabetic arthropathy. Chapter VI treats of the healing of fractures, pseudo-arthritis, epiphyseal injury, and intracapsular fracture. A supplement to this chapter concerns myositis ossificans, traumatic bone atrophy, and ischemic muscle contracture. The concluding chapter deals with bone transplantation and joint formation under the divisions (a) independent auto- and hetero-transplantation, and (b) arthroplasty and nearthrosis.

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I. S. TROSTLER, M.D.

treated in 1909, a girl of 16½ years, was cured by roentgenotherapy at that time. She married, gave birth to a normal child, and is now, 22 years later, in good health. The author discusses then the radiosensitivity of normal brain tissue and of the intracranial tumors, namely, tumors of the hypophysis and of the brain tissue proper, the possible mechanism of radiation therapy, and the general technic. His conclusions are so precise that they will be repeated here.

Roentgenotherapy as a curative procedure is indicated as soon as the first symptoms appear in adenoma of the hypophysis. Surgery should be considered only if there is a definite aggravation of the condition. Roentgenotherapy should be used as post-operative treatment method, both for palliation and prophylaxis if the tumor has been partially excised or can not be removed. Even after complete removal, radiation should be employed in order to prevent a recurrence. Roentgenotherapy is indicated as a symptomatic treatment method in cases in which the tumor cannot be exactly located but presents symptoms of intracranial pressure. It is not necessary to do a decompression before irradiation. If the symptoms are aggravated and trepanation becomes necessary, radiation therapy should be continued. Radiation therapy is also the only treatment method left if surgical intervention is contraindicated or refused by the patient.

ERNST A. POHLE, M.D., Ph.D.

ULCERS (ETIOLOGY)

The Dangers of Using Impure Mucin in Treatment of Peptic Ulcer. Andrew B. Rivers, Frances R. Vanzant, and Hiram E. Essex. *Jour. Am. Med. Assn.*, April 2, 1932, XCVIII, 1156.

The authors have demonstrated in certain specimens of commercial mucin the presence of large amounts of a secretagogue which by biologic tests seems to be histamine. The presence of this substance may be looked on as a contaminant, which can be avoided if proper methods of preparation are used. Until a consistently standardized, pure product is supplied, it will be impossible to evaluate the therapeutic use of mucin.

C. G. SUTHERLAND, M.D.

Gastric Mucin in the Treatment of Peptic Ulcer. Arthur J. Atkinson. *Jour. Am. Med. Assn.*, April 2, 1932, XCVIII, 1153-1156.

Clinical and experimental observations have indicated that a mechanical and a chemical factor are important in the healing of gastric ulcers and ulcers of the upper intestinal tract. Forty-three patients with history, signs, symptoms, laboratory evidence, and roentgen manifestations of peptic ulcer were treated with mucin. Remarkable results were obtained in patients who were previously having dis-

stress on dietary or alkali management. The author feels justified in believing mucin treatment is conducive to healing.

C. G. SUTHERLAND, M.D.

The Remote Results of Gastro-duodenal Ulcers. Treated with Parathyroid Extract. Max M. Lévy and Erna Lévy. *Arch. d. mal. de l'app. digestif*, October, 1931, XXI, 916-936.

Parathyroid extract has given no definite cure. The authors report four cases which gave absolutely negative results and four which were partially successful. Three cases presented niches, one of which completely disappeared, but the pain continued and resort was had to surgical intervention. Another showed partial disappearance of the niche, which did not alter the course of the disease. The niche in the third case did not disappear.

No other treatment or modification of diet was allowed, except the routine use of the extract (Col-lip) of the fresh gland, given subcutaneously every day or two in a series of 12 injections. There occurred a lowering (from 26 to 86 per cent free HCl and from 6 to 75 per cent of total acidity) of the free and total acidity of the gastric juice. The pain disappeared following the second or fourth injection, vomiting ceased, and the patient gained weight. However, there is no influence on the recurrence of the symptom complex. Only a minute rise in blood calcium could be noted.

This method may be of value as a pre-operative treatment, allowing a patient to become a better surgical risk. Due to its rapid results it can be used as a successful therapeutic adjunct, even though there is no definite healing of the ulcers, but only a distinct improvement of symptoms.

B. J. DELAUREAL, M.D.

The Clinical Symptoms and Radiologic Signs of Duodenal Ulcer. H. Annes Dias and Pedro Maciel. *Rev. Radiol. Clinica*, February, 1932, I, 143-158.

The clinical investigation makes the diagnosis presumptive; the X-ray examination makes the diagnosis certain and definite. The patient should undergo a complete examination in order that a definite opinion about the activity of the organ may be formed, as well as the relationships of lesions in other organs to the development of the duodenal ulcer. Clinically the ulcer is characterized by an increasing frequency of pain after eating. If the intervals between the taking of food and the onset of pain are becoming longer, the assumption may be made that the ulcer is healing, but there is always present a *locus minoris resistentiae* which may cause trouble at any time. Hunger-pain and early morning pain are two different phenomena. The latter is of great diagnostic importance and does not depend on the emptiness of the stomach but on the status of

TUMORS (THERAPY)

Radiosensitivity of Malignant Tumors of the Ovary. Lucien Mallet. *Arch. d'Électricité Médicale*, August-September, 1931, XXXIX, 289-300.

Radiotherapists and gynecologists agree that cancer of the ovary is often very radiosensitive and that radiation therapy should be employed in cases of incomplete surgical removal, recurrences after operation, or in the inoperable types of malignancy. Theoretically, this increased sensitivity conforms to the histologic structure of these tumors involving the genital glands, as demonstrated by Lacassagne. Practically, however, the results in the treatment of these tumors by radiation are very uncertain. Very often patients are referred to the radiotherapist with no information of any kind regarding the histologic structure or macroscopic appearance of the tumor at operation. In the absence of a microscopic examination of sections of the growth it is impossible to predict its sensitivity, and even when the histologic structure of the malignancy is known, the results of radiation therapy are hard to determine in advance, for considerable difference of opinion exists regarding the variations in sensitivity of the many types of ovarian tumors.

The author has studied the histologic structures of many forms of ovarian malignancies and the effects of radiotherapy upon these types. He classifies these growths as follows: Ovarian seminomas; endodermoid epitheliomas of Lecène; ovarian folliculomas; malignant papillary tumors; Wolffian epitheliomas; teratomas; spindle-cell sarcomas; lymphosarcoma; secondary carcinomas from the digestive tract, and other less common forms.

It was demonstrated that the seminomas and the folliculomas were very radiosensitive and that the sensitivity of the Wolffian epitheliomas was variable, depending upon the histologic structure. However, in this latter form radiotherapy was shown to be valuable for the prolongation of the life of the patient. The results obtained from this form of therapy in cases of papillary epitheliomas were not so favorable. It was found among the sarcomas that the radiosensitivity varied with the type of cell present, as the lymphosarcomas were very radiosensitive, while the spindle-cell sarcomas were more radioresistant.

It is the author's opinion that radiotherapy offers a valuable form of treatment in ovarian tumors if the case is carefully studied and treatment started as early as possible. A sufficient area should be covered by the rays to include the invaded areas as well as all possible lymphatic and peritoneal foci. The patients usually experienced no discomfort or pain as a result of the treatment, and in the author's experience bad results from anemia or absorption were rarely encountered. All new lymphatic foci were treated as soon as they were discovered. The author employs the following factors: Penetration,

200 K.V.; filtration, 1 mm. Cu plus 2 mm. Al; focal skin distance, 43 cm.; field, 16 × 16 centimeters. Seminomas, folliculomas, and lymphosarcomas were treated by maximum fractional doses of 500 r applied daily to each field. It was determined that in many cases 3,500 r to each field proved sufficient. More intensive treatment was administered to the papillary epitheliomas, Wolffian epitheliomas, teratomas, and spindle-cell sarcomas as from 1,000 to 1,500 r were given daily until each field received a total dose of from 4,500 to 5,000 r, on the surface.

Likewise, radium therapy produced favorable results which were found particularly valuable for pelvic application. The vaginal culdesac was irradiated by means of 10 mg. tubes of radium filtered by 2 mm. of platinum, and placed in an 8 mm. thick rubber colpostat. Depending upon the sensitivity of the tumor, applications lasted from eight to fifteen days. In the more resistant forms, such as the papillary epitheliomas, the surface application of radium in molds was employed.

J. N. Ané, M.D.

*Rare Renal Tumors. Louis Clive Jacobs and Lawrence H. Hoffman. *Jour. Urol.*, January, 1932, XXVII, 33-46.

In the renal region a palpable tumor of rapid growth, producing clinical symptoms, associated with cachexia, loss of weight, fever, etc., with an absence of urographic and urinary pathologic findings, is always suggestive of perirenal sarcoma. Radiography is apt to delineate a tumor mass, or the kidney shadow may have an indefinite outline.

Invasion of the retroperitoneal perirenal fossa by a tumor of the mixed-cell sarcoma type signifies the highest degree of malignancy.

Myxomas, while only locally recurrent, are equally grave as to prognosis.

The treatment of these conditions should be surgical and should consist of the complete removal of the kidney and tumor mass, including the adipose capsule. The perirenal fat should be dissected from the peritoneum and from the muscles of the posterior abdominal wall. The application of radium and deep X-ray therapy at the site of the nephrectomized area should be immediately instigated.

The prognosis is extremely grave, the expectancy of life being less than one year. Recurrences at the original site are common and are immediately followed by generalized metastasis.

DAVIS H. PARDOLL, M.D.

Radiation Therapy of Brain Tumors. Antoine Béclère. *Strahlentherapie*, Dec. 12, 1931, XLII, 807-880.

The author, who treated, in 1909, one of the first hypophyseal tumors reported, reviews in this article his experience with radiation therapy in brain tumors. It might be interesting to note that the patient

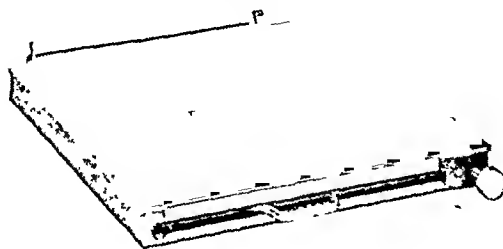
Are You Wondering Why Some Technicians Can Make Radiographs That Reveal So Much Detail---That You Are Missing?

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the vegetative nervous system. Early morning pain occurs at the time of the spasmodic phenomena (asthma, Miller's asthma, etc.) when as a result of hypertonus of the vagus an excessive secretion of the stomach and a hyperactivity are produced.

One should never forget the possibility of gastro-duodenitis which may resemble duodenal ulcer clinically and cause confusion in the diagnosis. In duodenitis there is a superficial lesion in the mucous membrane, but, the *muscularis mucosæ* is intact. In ulcer the lesion involves this layer. Direct signs are of greatest importance in diagnosing duodenal ulcer. A careful technic will, in most cases, demonstrate the niche. In duodenitis there is no niche but there are spasmodic deformities of the mucosa and marked deviations from its normal appearance, as shown by relief studies. Persisting deformities of the duodenal bulb, with the absence of a niche, suggest old lesions complicated by sclerotic retraction of the wall and periduodenitis.

E. T. LEDDY, M.D.

ULTRA-VIOLET LIGHT

Influence of Ultra-violet Light on the Glucose Tolerance of Rabbits. R. W. Root. Arch. Phys. Ther., X-ray, Radium, 1931, XII, 153-156.

Rabbits on a normal diet were fasted for 18 hours and then given 3 gm. glucose per kg. body weight by means of a stomach tube. Ultra-violet light administered immediately apparently increased the tolerance for high concentrations of glucose.

CHEMICAL ABSTRACTS.

Studies of the Dosage Problem of Ultra-violet Light. Part II.—How Far can Measuring Methods for the Determination of the Erythema Effect be Used for the Study of Other Biologic Effects of Radiation? R. du Mesnil de Rochemont and Heinz Kirchhoff. Strahlentherapie, Jan. 9, 1932, XLIII, 170-187.

The authors have continued their studies dealing with dosage problems of ultra-violet light. They state that for light biologic investigations with different wave lengths of ultra-violet rays separate intensity measurements for the various spectral ranges have to be carried out. The measurements can, for instance, be done with methods offering a selective sensitivity. The sensitivity curve of the measuring reaction must run parallel to that of the biologic object. Artificial sources of light, the spectral intensity distribution of which does not change much, can be calibrated with one single method which is sensitive to a broad spectral band.

The suggestion is made to use the effect of a certain dose of radiation of known spectral intensity distribution as a unit. The ultra-violet unit "Höhenson-neneinheit" (HSE) has been used by the authors. This unit is well defined by a definite photochemical reaction, the so-called Bering-Meyer iodine test. While this reaction was originally based on the spectrum of the quartz mercury vapor lamp, a comparison was carried out with the iodine test on the so-called Kandem arc light. The biologic reactions used for the experiments were the hemolysis of red blood corpuscles and the bactericidal effect on *Staphylococcus aureus*. It appeared that the erythema ratio of the quartz mercury vapor lamp and the Kandem arc light was the same as that of their spectral ranges possessing the hemolytic and bactericidal action. The same relation is found when using the cadmium cell. A different ratio is obtained, however, by means of the iodine test. In order to find, by means of the iodine test, on the Kandem lamp, the time for a dose which is equivalent to the ultra-violet unit in its erythema, hemolytic and bactericidal effect, it is necessary to multiply the time obtained by the iodine test on that lamp with the factor 0.58. It appeared that hemolytic changes in blood agar plates took place after application of from 2 to 8 ultra-violet units. A slight inhibition of the growth of staphylococci could be noted following exposure to 1/23 ultra-violet unit. The growth ceased after the application of 1/2 ultra-violet unit.

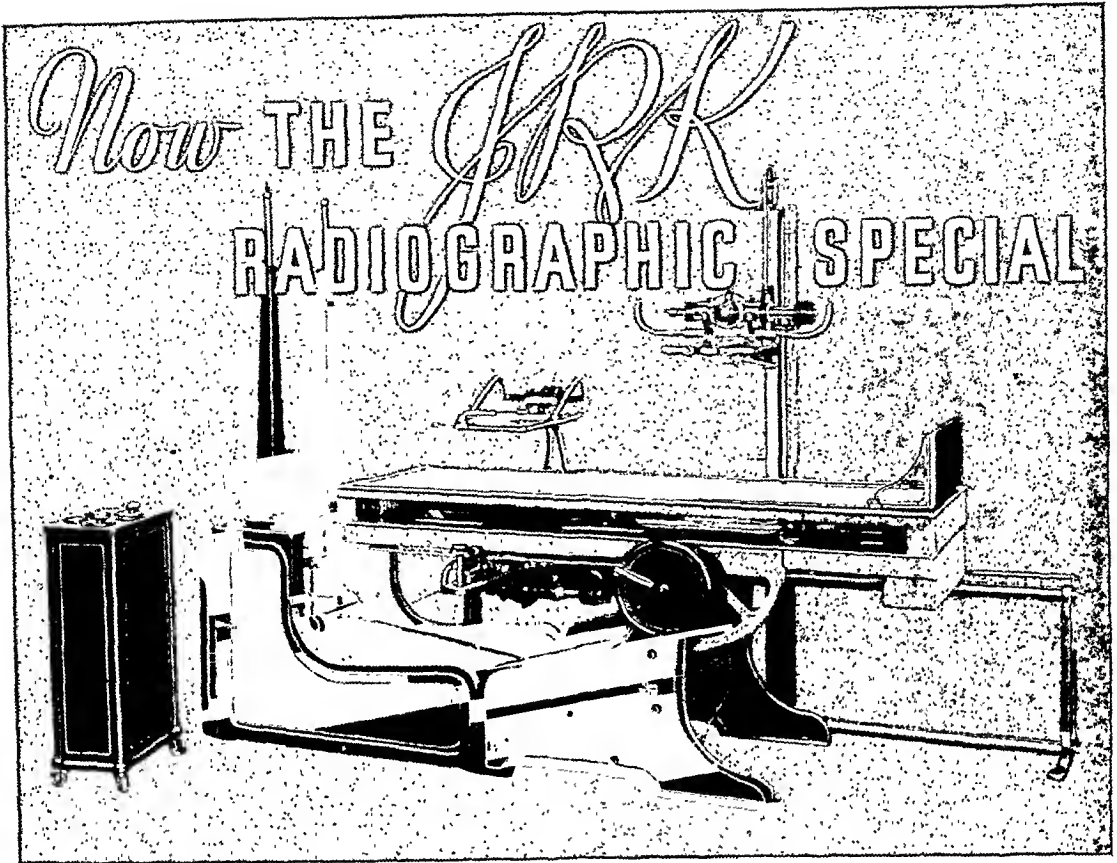
ERNST A. POHLE, M.D., Ph.D.

VENEREAL DISEASE

Roentgenotherapy of Gonorrheal Disease of the Male Adnixa. Konrad Neuschloss-Knüsli. Röntgenpraxis, Dec. 1, 1931, III, 1101, 1102.

Wetterer has reported the good results of roentgenotherapy in gonorrheal diseases of the male and female. He irradiated arthritis, adenitis, prostatitis, spermatozystitis, epididymitis, urethritis, and cervicitis. In males a chronic gonorrhea of the prostate and seminal vesicles is rather often very troublesome, neither massage nor diathermy seeming to help. Radiation therapy at the right time would have shortened the duration markedly in many cases. Epididymitis is also best treated by roentgen rays, in the author's experience. About one-half S.E.D. is applied to the prostate through two fields (anterior and posterior). A few cases are described.

H. W. HEFKE, M.D.

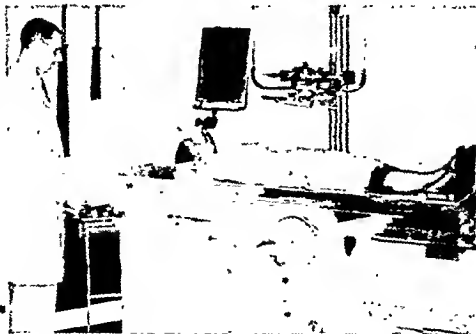


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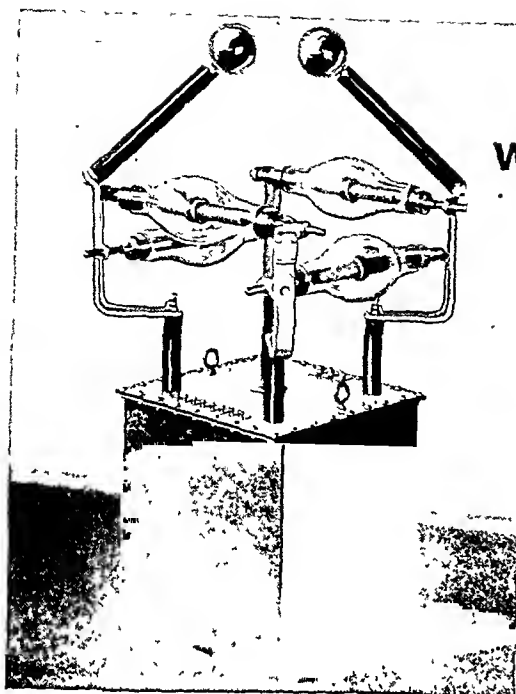
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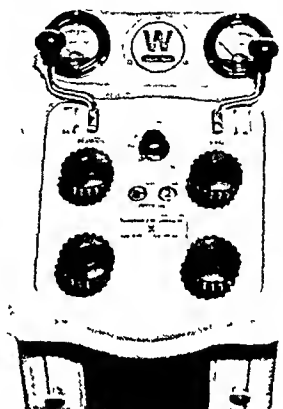
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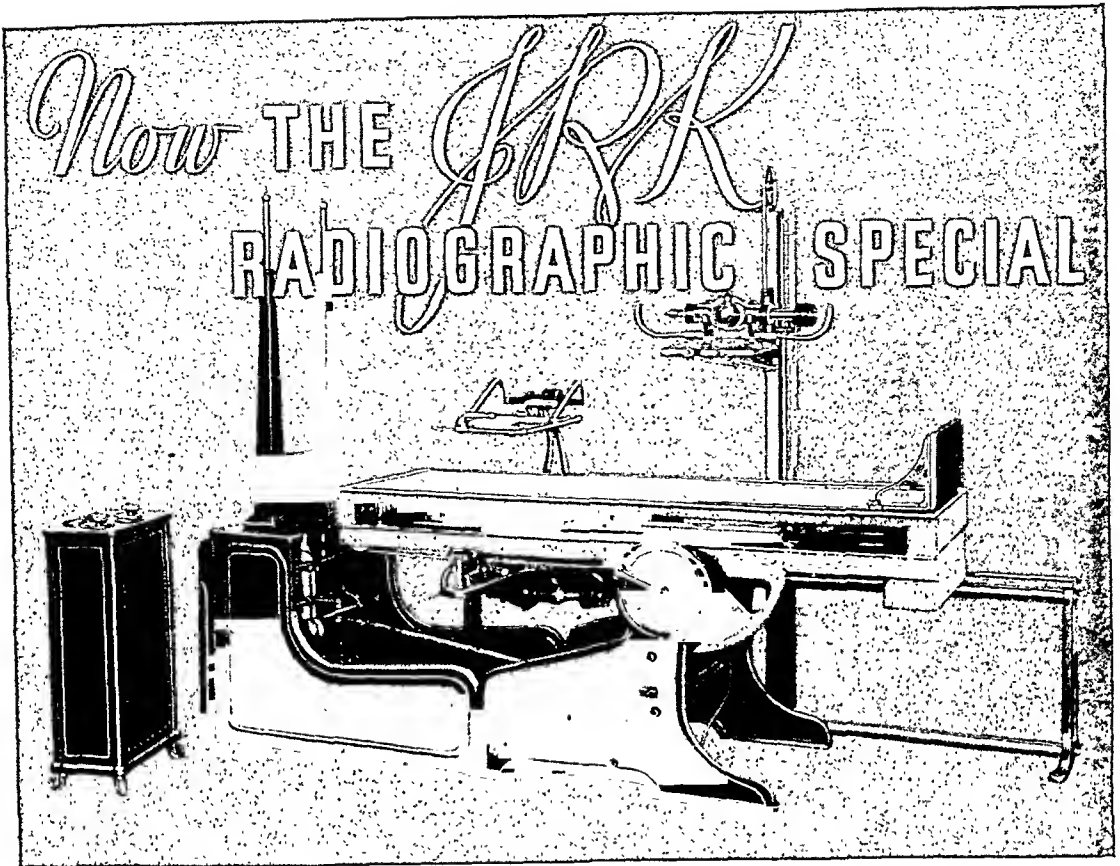
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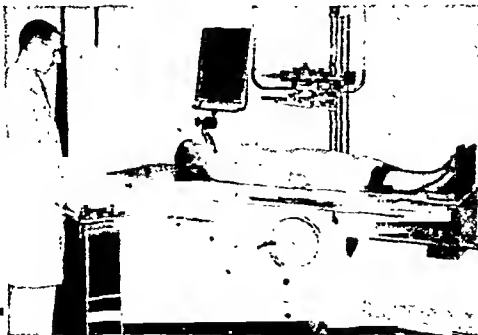


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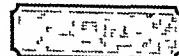
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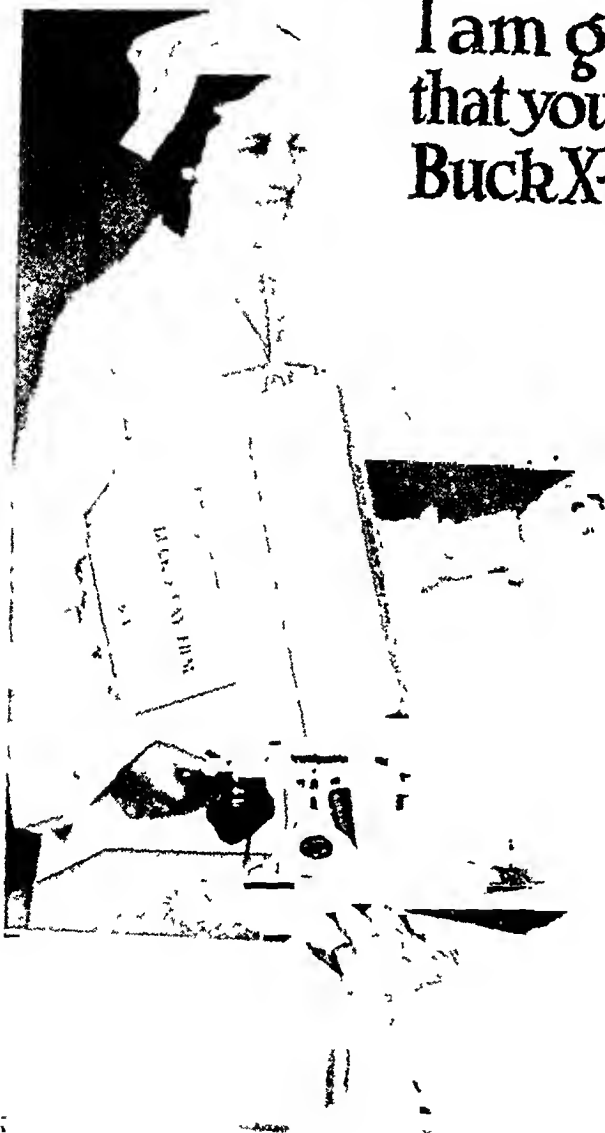


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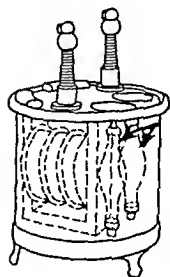
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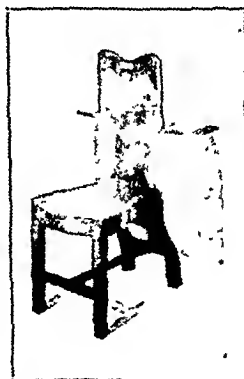
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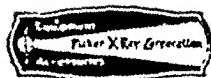
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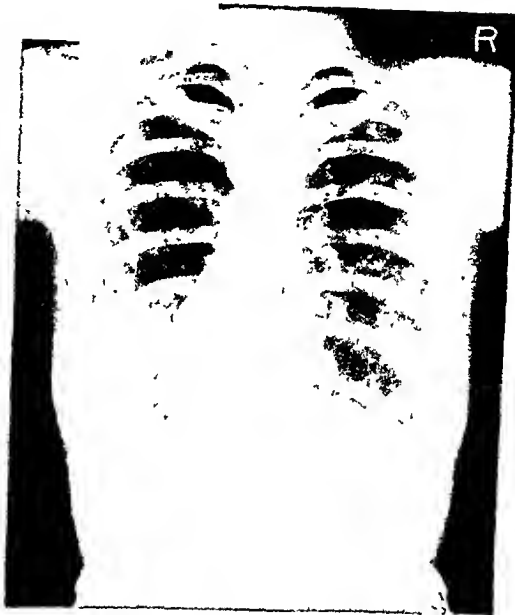
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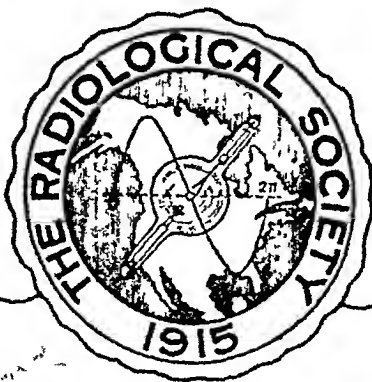
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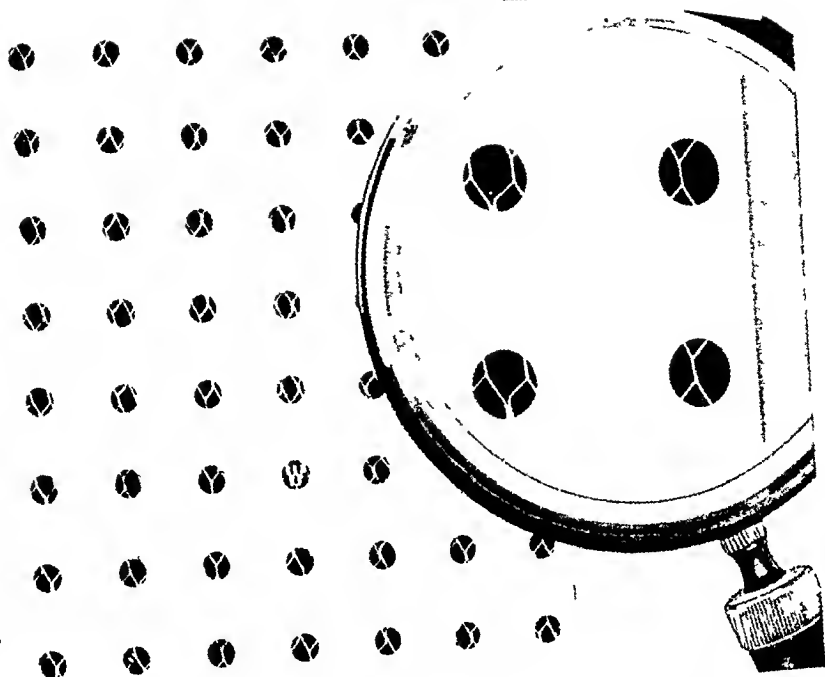
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Volume XIX

Number 1

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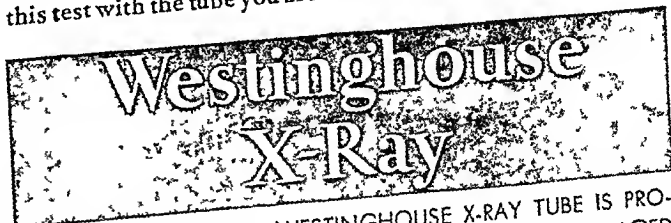
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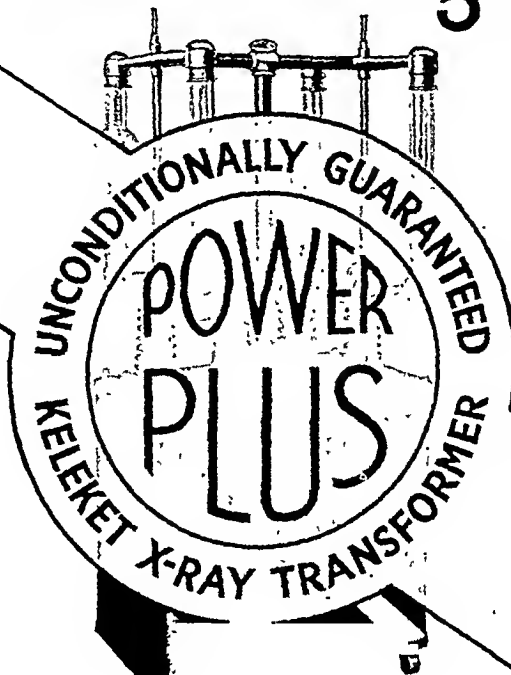
A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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RADIOLOGY

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VOL. XIX

JULY, 1932

No. 1

THE WORK OF THE NATIONAL AND INTERNATIONAL COMMITTEES ON X-RAY AND RADIUM PROTECTION¹

By LAURISTON S. TAYLOR, Bureau of Standards, WASHINGTON, D. C.
United States Member International X-ray and Radium Protection Commission

X-RAYS during the past thirty-five years have grown potentially more dangerous. They have increased in penetration, consequently are more difficult to shield. Higher penetration, necessitating higher line voltages, brings with it a greater electrical hazard. Furthermore, the tube currents are higher: hence, stray dosage is heavier.

Of course, we have an advantage over the pioneer X-ray workers in that we know a great deal about the properties of X-rays which they did not, so, by applying well established physical principles, we know better how to protect ourselves. The problem is carefully to determine the sources of danger and either eliminate them or provide protection against them. This is not simple, for it is practically impossible to completely absorb X-rays or gamma rays. We must be content to reduce their intensity to the point at which they are relatively harmless. In doing this we must balance the cost of equipment and ease of operation against the tolerance dose which may be received in a given time without harm.

Since the early years of X-rays, radiologists have recognized their danger and have sought to cope with it. Protection committees of the various radiological societies in this country and abroad have made safety recommendations with undoubted benefits.

These have, however, been limited by the fact that they have been more or less isolated efforts. Different societies' regulations have in some cases conflicted. Sometimes cities or States have made regulations which did not give proper consideration to the radiologists' needs. The underwriters, too, had a set of regulations. As usual, the existence of some impossible and contradictory recommendations has tended toward lack of observance of all. The average radiologist is neither engineer nor physicist and he could not be expected to choose accurately the salient points from among all of the less useful ones. Nevertheless, these many different proposals have had a profound effect on more recent proposals and their value must not be unduly discounted.

In 1928 there was in the United States no generally accepted set of X-ray safety requirements. A recognized safety code has perhaps existed longer in England than in any other country, its formulation directly traceable to a number of deaths from radiation burns several years ago. Germany followed England's suit with a more detailed set of requirements which were somewhat later enacted into legislation. Sweden inaugurated a set of proposals very similar to England's. Other European countries had little or nothing covering the matter.

These national recommendations or requirements had many points of conflict.

¹Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

Realizing the need of a unified safety code, the Second International Congress of Radiology at Stockholm in 1928 formulated for international use a set of safety recommendations which were based on those of England. This was accomplished only after a number of compromises by the English, United States, and German delegates. At the same time the Congress, recognizing that it was not in a position to adopt final proposals, appointed an International X-ray and Radium Protection Commission with one representative each from England, United States, Germany, France, Sweden, and Italy. The principal purpose of this commission was to study developments in the art of protection in order to improve the general recommendations as developments warranted.

The membership of the International Protection Commission is as follows:

G. W. C. Kaye, England (Honorable Secretary); Stanley Melville, England (Honorable Secretary); I. Solomon, France; R. Ledoux-Lebard, France (Hon.); G. Grossmann, Germany; E. Pugno Vanoni, Italy; R. Sievert, Sweden; Lauriston S. Taylor, United States.

As an outgrowth of the International Commission there was formed in the United States an Advisory Committee on X-ray and Radium Protection to deal with our particular problems and to draw up a set of definite recommendations. These recommendations were likewise to form a basis for proposals made to the International Commission. The Advisory Committee is composed of physicists, radiologists, and engineers, selected by the several medical-radiological organizations and the X-ray equipment manufacturers. Its membership is as follows:

Lauriston S. Taylor, Bureau of Standards (Chairman); R. R. Newell, M.D., and G. Failla, D.Sc., physicist, Radiological Society of North America; H. K. Pancoast, M.D., and J. L. Weatherwax, M.A., physi-

cist, American Roentgen Ray Society; W. D. Coolidge, Ph.D., and W. S. Werner, E.E., X-ray equipment manufacturers; F. C. Wood, M.D., American Medical Association; S. M. Withers, M.D., and C. F. Burnham, American Radium Society.

This advisory committee has recently completed a set of definite safety recommendations for X-rays and high voltage equipment which has been published and is available in reprint form. They have been officially adopted by the American Roentgen Ray Society and the Radiological Society of North America. The Bureau of Standards will use them as a basis for its opinions.

The question of the legal status of these recommendations has been frequently raised. They have none. The Committee feels that none is needed; that legislative enactment tends to stunt development and prevent healthy changes. We are free to admit that our present proposals may require changes in the future as the art develops. We wish nothing to interfere with the freedom for modification. It should be pointed out, however, that lack of legal standing will probably not in any way detract from their legal value. They are a recognized set of recommendations, drawn up by qualified representatives of the art and freely distributed to those interested. A court decision involving X-ray protection would in all probability, for lack of another source, be guided by these recommendations, and persons ignoring them may be held liable for negligence. We shall hear more on this question from Mr. Wanvig, of an insurance organization.

I should like now to make a few comments about the International X-ray and Radium Protection Proposals. The 1928 set was published in this country as "B.S. Circular No. 374" and was also printed in the radiological journals.⁴ The 1931 proposals follow the earlier ones except for a few modifications which I will enumerate later.

These international recommendations are purposely kept as simple as possible, serving merely as a guide, about which individual countries may shape their own more detailed proposals.

In formulating both sets of proposals there developed two particularly strong points of dissension. The first concerned the lead thicknesses required for shielding off X-rays of all voltages. The United States representative advocated the heaviest lead protection, while the German held that there was a tendency to over-protect. An average of the demands by the United States and Germany just about met the British requirements, so these were adopted with but slight modification. Since that time some very careful studies by several investigators have indicated that the lead thicknesses proposed by the International Committee were probably sufficient, these values being based on the average tolerance dose as determined in several independent studies. At the Paris meeting the German representative again sought unsuccessfully to reduce lead thicknesses. I might mention (parenthetically) that in the 1931 proposals, the lead protection values were extended up to 400 K.V. X-rays where 1.5 cm. lead protection is required.

The other chief point of dissension was on the high tension aerial height. The German representative wished the stipulation of 7.5 foot height as against 9 feet wanted by most of the other countries. Of course, 9 feet is ideal but frequently impractical. The Committee recognized this but held to the 9-foot height as a condition to be realized when possible. In this country we specify a minimum height of 7.5 feet, preferring to set an absolute limit rather than to recommend an ideal, this being the only instance wherein we dissent from the international recommendations.

I will go over some of the other changes very briefly. Emphasis was placed on the

improvement of working conditions, and more exact proposals were made to insure sufficient holidays and more frequent medical examinations for workers.

Recognizing that fluoroscopy presents one of the greatest hazards to the radiologist it was recommended that hand palpation be reduced to the minimum. Two countries even proposed that mechanical palpation be substituted for hand palpation in all work.

A clause was inserted, specially recommending the use of X-ray equipment having the high tension circuit completely inclosed in earthed conductors. This is now possible in a great variety of ways.

Special electrical precautions were likewise recommended for X-ray equipment in anesthetic rooms. While not stated in the proposals, the implication was for the use of equipment enclosed in vapor-proof containers.

The use of non-flammable films was recommended. In case flammable films are used, adequate precautions must be taken in storing them. It so happens that "adequate precaution" is nearly always prohibitively expensive.

Relative to radium protection, the table of lead thicknesses was revised downward; also to include protection for quantities up to 10 grams of radium. The Committee, recognizing that our knowledge of radium protection is very deficient, will lay particular stress on that question in 1934, and toward this end is going to invite the cooperation of other experts in the field. Among these and other changes were several recommendations made by the American Committee in its proposals, so that our views are well represented.

I might cite what I believe is specific evidence of the effect of the international safety recommendations. In the apparatus exhibit at the 1928 Congress, England was the only country exhibiting carefully protected X-ray apparatus. It may be recalled that at that time England was the only

country having X-ray protection recommendations of long standing and the international recommendations did not exist. As contrasted to this, the apparatus exhibit at the 1931 Congress contained protected apparatus from all countries. The inference is that, with the weight of the international recommendations behind them, the manufacturers followed the obvious course and built their apparatus in accordance with them.

A few words now about the X-ray protection recommendations of the U. S. Advisory Committee. I shall not go into details since the speakers following me will do this, but will emphasize a few of the more important features that particularly concern present-day installations. These recommendations are contained in the "Bureau of Standards Handbook No. 15," which may be obtained from the Superintendent of Documents.

Protective plasters, leaded rubber and the like are considered to be unsatisfactory for providing permanent protection of more than 1 mm. lead equivalent. This limits their use to radiographic work below 75 K.V., which thus permits the use of plasters in the smaller offices but precludes their use for any sort of therapy installations. One of the causes for this restriction is the fact that the protective qualities of plasters fall off rapidly above about 100 K.V., thus requiring for high voltage mechanically prohibitive thicknesses.

Protective glass windows are required to have the same lead equivalent as the remainder of a room. I may point out that in nine-tenths of the installations I have seen, both in this country and abroad, insufficient thicknesses of lead glass are used. For example, a 200-K.V. therapy room frequently has the required 4-mm. lead walls and yet a large window with only 1-mm. lead equivalent—an obvious hazard. Likewise, many fluorescent screens are backed by insufficient lead glass. This common fault is particularly dangerous and yet very readily

remedied. In the installation of sheet lead, reasonable care should be used. I know of one installation in which an otherwise satisfactory lead wall for a therapy room was perforated every six inches with a large tapper nail. Enough radiation passed through that wall to clearly fluoroscope the hand.

Open tube bowls are not recommended for any sort of installation. Closed bowls may be used for diagnostic and superficial therapy tubes, provided protective sleeves extend down the tube arm a sufficient distance. Deep therapy tubes must be completely surrounded by a protective enclosure. If the tube has a built-in protection, the surrounding enclosure may be reduced by an equivalent amount.

The minimum height of permanent high tension conductors is given as 7.5 feet. It should be emphasized that this applies to meters, stabilizers, cord reels, and cords (when not in use).

For use in anesthetic rooms all X-ray equipment must be inclosed in vapor-proof containers. In this connection it is of equal importance that the operating switches be similarly enclosed.

The Committee gives its unqualified endorsement to the sole use of slow-burning, safety-base films. It furthermore endorses the recommendations of the National Board of Fire Underwriters for the storage of inflammable film already present.

The recommendations close with a set of operating rules for technicians, nurses, etc., which should result in safer and more healthful working conditions.

It is hoped that the recommendations may prove to be of assistance to all workers in the field. In speaking for the Advisory Committee on X-ray and Radium Protection, I may say that it will be very glad to advise the radiologist in solving his general or specific problems relating to protection.³

³Read before the Radiological Society of North America, Nov. 30-Dec. 4, 1931.

X-RAY PROTECTION FROM THE MANUFACTURER'S VIEWPOINT¹

By WILBUR S. WERNER, E.E., COWINGTON, KENTUCKY

INTRODUCTORY to this paper, may it be stated that an attempt will be made to express the views of manufacturers in general? Individualism will be avoided.

Throughout the past, there has been a constant desire in the minds of manufacturers to improve and safeguard equipment used roentgenographically. Efforts have been continually directed toward this end. A glance backward to the old induction coils with their "open," or "live" control switches, unsupported high tension wires, unshielded X-ray tubes, etc., will cause appreciation of the tendency toward advancement.

However, inception of the American Safety Committee offered a directed means to promote collective effort which would bring to the foreground protective measures for unified acceptance.

The recommendations presented by this Committee resulted from careful investigations and were based on conservative analytical thought. It is not suggested to the roentgenologist that he suddenly discard his present apparatus, nor is it desired of the manufacturer immediately to disrupt his current production. A reasonable transition period will permit both roentgenologist and manufacturer to bring equipment in use and in production up to the correct standards set by the Committee, without working a severe hardship on either. There is, however, a very human tendency to retard acceptance of new presentations and regulations, particularly when acceptance incurs changes and cost.

Adoption of the Safety Committee's recommendations will add an initial burden to roentgenologist and manufacturer alike;

however, the improved conditions resulting from acceptance will be worthy of the effort.

Co-operation between user and manufacturer is indicated to secure the best end-result. At times a manufacturer is requested to make a type of installation which good judgment advises is against the best interests of the user. Ordinarily the requested limitation of protection arises from a desire to economize. Manufacturers also have at times been at fault when designing equipment in keeping in mind a low competitive sales price rather than the utility and safety of the product. This practice has been encouraged by some laymen hospital boards which purchase X-ray equipment on price basis only. This is due to their lack of intimate knowledge of uses and details of equipment, and of types of installations. Correction for this is suggested by giving the roentgenologist final approval on purchases made for hospital use. These last conditions are only mentioned as they offer little stumbling blocks in the paths of roentgenologists and reliable manufacturers in the continuity of advancement of the art toward the ultimate goal.

The manufacturer can and should play an important rôle in bringing X-ray laboratories up to the standards suggested by the Safety Committee. Every effort should be directed not only toward having new designs of equipment conform to the protection recommendations, but the manufacturer should assist the roentgenologist to bring his installed equipment up to the same specifications whenever this is practical or possible.

The design of the equipment is only a part of a good safety program. The manufacturer can further assist by giving correct layout information when new laboratories

¹Read before the Radiological Society of North America, at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

are planned. Correct protective lining of X-ray rooms, installation of safety signals, cut-out switches on machine room doors, seclusion of inter-connecting cables in conduits, etc., are very important. The manufacturer, in presenting a proposed layout of a laboratory, can incorporate all these features, giving the correct individual specifications for each detail.

In the past, electrical hazards, because they were easily visualized, have been given close attention by manufacturers. Even high voltage and large capacity, shock-proof equipment is being presented at the present time. As a result, there has been a very small percentage of serious injuries from this cause. Protection from stray radiation, however, has not been given the consideration that experience has indicated, and special attention should be directed to this matter by both roentgenologist and manufacturer.

A few of the recommendations of the Safety Committee are presented below.

1. All protective materials should be marked by the manufacturer to show the lead equivalent thickness of the material. For protective materials containing other than lead as an absorbing medium, the voltage at which the equivalent applies should be given.

2. Minimum lead equivalents per voltage are recommended by the Safety Committee.

3. The use of movable protective screens is dangerous and should be avoided.

4. Protective tube inclosures should surround the tube. Open bowls should be discarded.

5. Exposure and treatment rooms should be correctly X-ray-proofed in accordance with the quality of radiation employed. When lead lining is used special care should be given to the overlapping of joints and to the means of application.

6. X-ray and control rooms should be located to avoid dampness and to provide ample ventilation and light.

7. In fluoroscopy, when a tube with exposed high tension parts is used, the tube and its conductors should be shielded with a grounded metal barrier, or its equivalent.

8. Overhead conducting systems should have a normal minimum clearance to ground of seven and one-half feet. Aerial brackets must be able to withstand additional dead weight of 50 pounds.

9. A foot switch should have a rigid shield above the button to prevent accidental closure of the switch by stepping upon it. Furthermore, an auxiliary series switch should be located on the control panel to cut the foot switch entirely out of the circuit when it is not in use.

10. Sparking distance standards are set by the Safety Committee for the purpose of specifying spark-over distances.

11. When a high tension generating unit cannot be installed in a separate machine room, it should be isolated with a grounded barrier, or its equivalent.

12. The Safety Committee especially endorses the use of the slow burning, or safety base, X-ray film, as this film offers no greater fire hazard than ordinary newspaper in the same form.

13. Safety films (cellulose acetate) may be stored as letters are filed. However, nitrocellulose films may be stored only in protected vented fireproof vaults, in keeping with the regulations of the National Board of Fire Underwriters.

In conclusion, may it be stated that, inasmuch as both roentgenologists and manufacturers should appreciate the desirability of use of the protective measures recommended by the Safety Committee, both agencies should mutually co-operate to bring about their universal acceptance.

PROTECTION IN X-RAY THERAPY¹

By WILHELM STENSTROM, PH D., Section of Biophysics and Cancer Institute,
University of Minnesota, MINNEAPOLIS, MINNESOTA

THE dangers connected with roentgenotherapy have been emphasized so frequently that they are quite familiar to roentgenologists. Even the best informed men may, however, become careless. All too often do we learn of prominent physicians and scientists who have to pay heavy penalties for neglecting to take all the necessary precautions when they are working with roentgen rays. It is, therefore, well to keep up the vigilance and to review, from time to time, the problem of protection.

The different radiologic societies have repeatedly contributed valuable discussions and instructions concerning protective measures. Recently this has culminated in a concise effort to give specific recommendations. An Advisory Committee on X-ray and Radium Protection was formed. This Committee was supported by the Bureau of Standards and their physicist, L. S. Taylor, became its Chairman. The results are published in the Bureau of Standards Handbook No. 15, "X-ray Protection," which can be obtained for ten cents from the Superintendent of Documents, Washington, D. C. The recommendations contained in this book of 26 pages should, of course, be followed as closely as possible, and it is hoped that it will be consulted by all roentgenologists.

Old installations should be rechecked to determine if the protection is adequate and new installations ought to be arranged according to the advice contained in the pamphlet. With such precautions taken, we can feel fairly safe; but we must still remember that nothing is fool-proof and that no construction can prevent accidents. It is also necessary that the roentgenologists and

the technicians be thoroughly informed of possible dangers and be always on their guard during work. It may not always be possible to follow in detail the rules laid down, but, by using good judgment, it will be possible to avoid accidents. Without referring to the details, we will take up some of the problems for discussion.

Let us first consider the danger connected with the electric current. The low voltage line carrying current to the control stand and the primary of the transformer is usually considered as offering little danger. This line must, however, be satisfactorily insulated and must be heavy enough to carry the maximum required current. It may sometimes be a temptation to replace a burned-out fuse with a heavier one, but this should not be done unless it is definitely known that the wiring, as well as the machine, can stand the heavier load. The line should occasionally be inspected for faulty insulation and broken or worn wires. This is particularly important if the control stand is being pushed around a great deal. The switches should be covered so that nobody can touch the "live" wires. The reason we usually do not get a severe shock when we touch a low voltage wire is that the contact surface, as a rule, is very small. If the surface is large, the contact good, and one part of the body well grounded, then the shock may be severe enough to cause death.

The high voltage line is so much more dangerous because the electric current there can jump a considerable distance through the air and because enough current can be forced through a very small contact surface to cause severe injury, or death. The only satisfactory way to avoid danger from the high voltage is to have it so arranged during

¹Read before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

treatments that it is practically impossible for anybody concerned to come within sparking distance of any portion of the high voltage line. The sparking distance, as well as the corona, is smaller the greater the diameter of the conductor and the smoother its surface and curves.

The danger of the exposure to X-rays is emphasized by the accumulative effect. Unfortunately we know as yet very little about the extent to which it takes place, as it is different in different tissues. The production of erythema reaction with divided dosage has been fairly well determined, but other changes in the skin do not seem to take place in the same rhythm. Repeated small dosage, for instance, may produce atrophy, and even necrosis, without any preceding erythema. The danger of too much exposure to the operator is due almost entirely to such accumulation. It has, however, happened in the past that operators sometimes have exposed themselves to such an extent, while studying the behavior of the tube, that serious injuries have resulted from a single or, perhaps, a few exposures. If such a thing should happen with the knowledge now available, it must be considered gross neglect. Injuries to an operator or other persons stationed nearby as a consequence of repeated daily exposure to small amounts of radiation, cannot be guaranteed against, for the simple reason that we do not know how radiation affects the cells and the whole organism.

What is the upper limit of radiation we can tolerate? Small amounts of radio-active material deposited in the body have proved to be quite dangerous. In some instances, the destruction of tissues from their radiation has been great enough to cause death directly. A recent study has shown the frequency of bone sarcoma in a group of radium workers so high as to make it probable that the sarcoma resulted from continued exposure to the rays from the de-

posit of radio-active substances. All living beings are, however, continuously exposed to very minute amounts of radiation from these elements, and the question has even been raised if such radiation is not necessary for life. Here is a considerable gap in our knowledge and a field open for future research. We have, however, to decide upon what may, for the present, be considered safe. I believe that the body as a whole during a number of years (during the time the person is engaged in this type of work) can safely stand the amount of radiation which, when given at one time, would produce an erythema. In many instances such an exposure has been tolerated without any apparent ill effect. The protection may be considered adequate for the operator when the intensity of the radiation at the point at which he is placed with the machine running is at all times so small that it would require at least 10 years to obtain an erythema dose (or 600 r) with the average number of treatments. In order to obtain such protection, it is necessary to have the treatment room lead-lined and to have the operator outside watching the tube and the patient through a lead glass window.

The precautions necessary to protect the patient at each treatment require primary attention. The screening must be so arranged that no portion of the body outside the field receives more than a small fraction of the dose; as an upper limit we may say 5 per cent of the field dose. It is well to keep in mind that rays are given off from practically every portion of the inner surface of the tube. If the rays coming from the arms of a glass tube are permitted to reach the skin unobstructed, while the radiation from the target is heavily filtered, they may be intense enough to cause considerable reaction. It is evident that the distance from target to the nearest portion of the exposed skin must be checked with greatest care, at least to within one centi-

meter. If the exposure should be given at eight inches target-skin distance when figured for a ten-inch distance, the obtained skin dose would exceed the calculated dose by more than 50 per cent. It is at least as evident that the "wrong" filter may give rise to serious consequences. Many schemes have been devised to eliminate mistakes of this kind. The various filters have, for instance, been marked with different colored bands which are in direct view of the operator during treatments. Each filter may, when in position, close the electric circuit of a corresponding colored light bulb, etc. Such arrangements are of great value. Perhaps the most satisfactory method is the use of a large ionization chamber immediately under the filter. This should then be connected to a galvanometer placed in front of the operator. The readings corresponding to the different filters differ greatly. If the operator writes down the reading during each treatment, a record is obtained which can later be used to check up on the filter, if that should be called for. If a treatment were calculated for 1 millimeter copper filter but were given without any filter at all, the dose at the skin would amount to at least ten times the calculated value.

The current and the voltage must also be checked carefully. It is usually advisable to have two milliammeters in series. If at any time they do not register the same, they should both be tested before treatments are continued. A static voltmeter can be used to indicate any untoward change in the potential, and a sphere gap can be used for the determination of the crest voltage and as a safety valve against sudden rises in the potential. It is important to have the X-ray intensity standardized and, of course, just as important to watch against any intensity changes afterward. Such an ionization chamber as was recommended for checking the filter is of great value as an indicator of

any change in the X-ray output. When several "fields" are used in treating a patient, great care must be taken that no overlapping occurs unless this has been taken into consideration. The summation of the dose from the different fields should be determined before the treatments, and the amount of radiation so regulated that overdosage results neither on the skin nor within any part of the body. Charts showing the distribution of radiation in tissues, or substances of approximately the same absorption coefficient for X-rays, are needed for this purpose. It should be kept in mind that it is also a serious thing to give too small a dose, as it prevents the patient from obtaining proper benefit from radiation and may rob him of his only chance to improve.

The danger to the patient from accumulation of radiation must be guarded against. Previous treatments and fluoroscopic and photographic exposures must be taken into consideration. The number of treatments to any one area must be kept within safe limits. It is difficult to determine this limit as it depends upon a number of factors. We consider, as a rule, that four full series of high voltage therapy to a certain area of the body are all that can be given without considerable danger of too much atrophy. Years afterwards such atrophic changes may be followed by necrosis. By a full series we mean such an amount of radiation given within three weeks that, for instance, the skin shows a rather intense erythematous reaction. The interval between two successive series should not be shorter than eight weeks.

Most recommendations for protection are of a general nature; the exact details have to be determined separately for each installation. The thickness of lead (or lead equivalent) needed around the tubes and as lining throughout the treatment room is given for different voltages in the pamphlet

"X-ray Protection." It is evident that a rather thick concrete wall or floor does not require the same thickness of lead covering as a thin wall made of tile or wood. Tables giving the thickness of different types of material which stops the radiation to the same extent as 1 millimeter of lead would be of great value. Such figures vary, however, with the hardness of the rays and should, therefore, be determined for the different potentials employed during treatments (for instance, for 50, 100, 150, and 200 kilovolts). Paragraph 1.15 in "X-ray Protection" reads: "All X-ray protective materials shall be indelibly marked by the manufacturer in such a manner as to readily show the lead equivalent thickness of the material (See Table II). For protective materials containing other than lead to cause the high absorption, the voltage at which the equivalence applies shall be given." This recommendation will, no doubt, receive general adoption in the future and much confusion will thereby be avoided.

Tables of the type mentioned above will, however, still be needed and it is hoped that they will be worked out and made available by the Bureau of Standards. Of course, it is advisable to keep as great as possible the distance between the X-ray tube and those who occupy surrounding rooms. However, distance does not contribute as much to protection from X-rays as is generally thought. Ten meters of air do not absorb appreciably more than does 1 cm. of tissue. The intensity of the harder rays, therefore, falls off approximately in proportion to the square of the distance. Often 50 cm. target-skin distance is used for treatments and the intensity at this distance may, therefore, be used as a standard for comparisons. At five meters' distance the intensity is about one hundredth as much, and at 16 meters' distance one thousandth as much. The intensity ought to be reduced by ten thousand and at 16 meters' distance would, therefore, still

be too high if no other protection were used. An X-ray tube near a window might send a dangerous amount of radiation into a nearby building.

In order to find out whether or not the protection is adequate, measurements of radiation intensities in the surroundings of the X-ray tube should be made. The simplest method of testing for stray radiation is to use a fluorescent screen. If this is placed in a box, with an opening for the eyes which shuts out light completely when pressed against the face, a fair sensitivity can be obtained after the eyes have become accommodated to the darkness. The test should preferably be made at night. If fluorescence is noticed, the intensity of the radiation is too great for continued exposure of any person. The photographic method is more sensitive and can be used for quantitative measurements of the radiation. Dental films may be exposed at suitable places, for instance, near the operating stand, in the pockets of the personnel, etc., for one or two weeks. Other films may be exposed to known amounts of radiation directly under the X-ray tube. If all the films are of the same sensitivity and are treated in exactly the same manner, developed to the same extent, etc., it can be assumed as a first approximation that films showing the same density have been exposed to the same amount of radiation. Ionization methods can also be used for such tests if the instruments are sensitive enough. In this respect, probably the Geiger counter offers the best opportunity.

SUMMARY

All individuals concerned in the practice of X-ray therapy should be thoroughly familiar with the dangers connected with their occupation.

The recommendations furnished in "X-

ray Protection" must be followed as closely as possible.

Tests must be made to determine the amount of stray radiation in the immediate

surroundings of an X-ray therapy room.

If these three rules are strictly upheld, accidents and injuries due to X-ray therapy will become rare.

Ocean Sediments Have High Radium Content.—Radium is more abundant in the sediments of the deep ocean bottom than it is in land rocks. The deep sediments have more than four times as great a radium content as the granitic rocks on land, and more than ten times as much as land basalts. The deeper the sediments, and the farther they are from shore, the greater their radio-active content.

These are among the facts laid before the American Geophysical Union, at Washington, by Dr. Charles S. Piggot, of the Carnegie Institution of Washington.

The samples of ocean-bottom sediments analyzed for radio-active elements are not at all numerous as compared with the land rock and earth samples similarly examined, Dr. Piggot says; but insofar as any generalizations can be made, the facts are as he stated.

This accumulation of more highly radio-active deposits in the deepest and most remote places in the ocean may be having an appreciable effect on the course of the earth's geological history, he said. For one thing, such deposits can well act as blankets to slow down the escape of the internal heat-energy of the earth.

A number of theories of probable sources of these radio-active deposits have been examined and discarded. Dr. Piggot does not be-

lieve that they have been concentrated by living organisms and deposited by the down-sifting of their skeletons after they have died. While some organic sediments have high radium contents, he said, on the average the non-organic red clay sediments are three times as radio-active. Neither is the theory of submarine volcanism, with intense chemical action where water and hot magma are in contact, any more tenable, he thinks. Such action would be more or less "spotty" in its effects, whereas radio-active sediments are found everywhere.

Recognizing that much research yet remains to be done on the question, Dr. Piggot inclines to the belief that the origin of the radio-active content ocean-bottom sediments is to be sought directly in the rocks of the earth's crust. These are worn or broken down into the fine particles that eventually settle on the bottom of the sea, some of them carrying all their original radio-active elements with them, others having a part of the original content removed by chemical processes occurring on the way. Where the sediments are mixed with the remains of minute organisms, Dr. Piggot thinks, these latter tend to dilute rather than increase the total radio-active content.—*Science Service*.

RADIUM PROTECTION¹

By G. FAILLA, D.Sc., Memorial Hospital, NEW YORK CITY

PART I.—GENERAL CONSIDERATIONS

IT is well known that radio-active matter is distributed throughout the earth's crust. In general, the concentration does not vary greatly from point to point, but in certain localities (for instance, where radium ores are found) it may be much higher than the average. The radium content of ordinary rocks is roughly one gram in one million tons, or about one-half million cubic yards of rock. On this estimate, the Empire State Building, weighing 300,000 tons, contains 0.3 gram of radium in its walls and floors. In addition, there is always some thorium present in all rocks.

The presence of radon ("radium emanation") and thoron ("thorium emanation") may be detected everywhere in the atmosphere. It has been estimated that the amount of radon found in the air requires the existence of about one gram of *freely emanating* radium per square kilometer of surface. Since only a small part of the radium in the earth is freely emanating, the amount actually present is much greater than this.

The gamma radiation from these radio-active substances or their products of disintegration, is present everywhere. Furthermore, there is a type of radiation more penetrating than gamma rays (cosmic radiation) which reaches the earth from interstellar space. Accordingly our bodies are "bathed" constantly in a rarefied "atmosphere" of radiation which penetrates to the innermost cells. In addition, the food we eat, the water we drink, and the air we breathe contain small amounts of radio-active matter, and the cells in our bodies are

also bombarded by radiations of the alpha and beta ray types, which otherwise could not reach tissues at an appreciable depth below the skin.

It is evident, therefore, that living matter can tolerate continuous exposure to a certain intensity of radiation of the type under consideration, which for convenience we may refer to as "ionizing radiation." It may even be that a certain intensity of such radiation is essential to life, or that, at any rate, it facilitates living processes. From a different point of view, the theory has been advanced that the presence of such radiation has played a considerable part in the process of evolution. At least it has been demonstrated experimentally that the number of mutations observed in *Drosophila* may be increased considerably by the administration of X-rays under suitable conditions.

The above considerations, of course, give us a lower limit for the intensity of radiation which can be tolerated continuously by living matter. The upper limit is unquestionably much higher, but is very difficult to determine. It probably varies considerably from one species to another, and among different individuals. For instance, we have at the hospital a canary which has been continuously (day and night) in a beam of X-rays for about five months. The intensity of radiation at the point where the cage is suspended has been increased gradually from 0.018 r per minute to 0.044 r per minute, for reasons which need not be mentioned here. In this time the bird has received about 6,000 roentgens of hard X-rays without apparent deleterious effects. I think all radiologists will agree that the same dose administered to the human body in the same way, would probably be fatal.

¹Read before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1931.

On the other hand, we cannot say that this dose is entirely harmless to the canary, because marked effects may develop later, even if the exposure should end now.

This point should be borne in mind in attempting to estimate the upper level of the tolerance dose for the human being. An individual may be exposed to a large dose of radiation in a period of a few weeks but the harmful effects may not be manifest until some months or perhaps years later. On the other hand, exposure to radiation of sufficient intensity to produce a distinct physiological effect in a few months is not necessarily harmful, because the individual may recover completely if he is no longer exposed to the radiation. Accordingly we must always bear in mind that there is a latent period in the manifestation of radiation effects and that there is recovery from these effects if they are not too severe. It follows, therefore, that the upper limit of the tolerance dose is different under different conditions.

We may now define the safe upper limit of the tolerance dose, or simply the "tolerance dose," as that dose of radiation which experience has shown to produce no permanent physiological changes in the average individual. This is general enough to include all conditions encountered in practice. It should be noted that the term "dose" as used here is not synonymous with "quantity of radiation." It involves particularly the time element. Thus the tolerance dose in the treatment of a patient may be the amount of radiation which, *administered in the course of a few hours*, will produce no permanent skin changes. Or the tolerance dose in the case of a temporary technician may be the amount of radiation which he can receive *during the time he works with radium* without suffering any permanent injury. If the technician is to work with radium permanently or for a number of years, it is best perhaps to speak of the "tol-

erance intensity" rather than the tolerance dose.

1. LOCAL EFFECTS

In the preparation of radium applicators or the process of applying radium to a patient, the hand of the operator is necessarily the part of the body which is closest to the radium. Consequently the hand, and particularly the fingers, will always receive much more radiation than any other part of the body. It is necessary, therefore, to consider only the hands for the local manifestations of exposure to radium.

(a) *Individuals Exposed to Radiation for an Indefinite Period of Years.*—This refers to the radiologist or surgeon using radium in his practice, who will, presumably, continue to do so indefinitely, and also to physicists and technicians who intend to work with radium permanently.

It is difficult to give a definite estimate of the monthly dose which the fingers can receive over a period of years without showing radiation effects. As a matter of fact, all persons who have worked regularly with appreciable amounts of radium for more than two years show some definite skin changes in their fingers. Unless the individual has been very careless, however, these changes are not permanent nor very marked, and in general they would not be noticeable some years after the exposure to radium ceased.

On our assumption that the individual is to continue his work with radium, it is important to know whether further exposure of the same degree will gradually aggravate the conditions, or whether a sort of "equilibrium" is reached at a certain time, beyond which the condition of the skin remains stationary. These questions cannot be answered categorically for several obvious reasons. However, we may approach the problem from a different angle and get some definite information of practical value.

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By G. FAILLA, D.Sc., Memorial Hospital, NEW YORK CITY

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The gamma radiation from these radio-active substances or their products of disintegration, is present everywhere. Furthermore, there is a type of radiation more penetrating than gamma rays (cosmic radiation) which reaches the earth from interstellar space. Accordingly our bodies are "bathed" constantly in a rarefied "atmosphere" of radiation which penetrates to the innermost cells. In addition, the food we eat, the water we drink, and the air we breathe contain small amounts of radio-active matter, and the cells in our bodies are

also bombarded by radiations of the alpha and beta ray types, which otherwise could not reach tissues at an appreciable depth below the skin.

It is evident, therefore, that living matter can tolerate continuous exposure to a certain intensity of radiation of the type under consideration, which for convenience we may refer to as "ionizing radiation." It may even be that a certain intensity of such radiation is essential to life, or that, at any rate, it facilitates living processes. From a different point of view, the theory has been advanced that the presence of such radiation has played a considerable part in the process of evolution. At least it has been demonstrated experimentally that the number of mutations observed in *Drosophila* may be increased considerably by the administration of X-rays under suitable conditions.

The above considerations, of course, give us a lower limit for the intensity of radiation which can be tolerated continuously by living matter. The upper limit is unquestionably much higher, but is very difficult to determine. It probably varies considerably from one species to another, and among different individuals. For instance, we have at the hospital a canary which has been continuously (day and night) in a beam of X-rays for about five months. The intensity of radiation at the point where the cage is suspended has been increased gradually from 0.018 r per minute to 0.044 r per minute, for reasons which need not be mentioned here. In this time the bird has received about 6,000 roentgens of hard X-rays without apparent deleterious effects. I think all radiologists will agree that the same dose administered to the human body in the same way, would probably be fatal.

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same every day. The daily dose is, then, so small that at the end of two years the only visible skin change is a slight reddening and shiny appearance of the skin around the finger nails. *Continuing to work under these conditions*, there will be no sudden change in the skin reaction and one can tell (long before the danger point is reached) whether the skin is gradually getting worse. At the end of two years, enough time has elapsed for the establishment of a certain equilibrium involving the accumulation of daily doses, the latent period, the rate of recovery, and the degree of effect present. Our experience with effects produced under exactly these conditions is too limited to permit us to state that such equilibrium is permanent, but we can say definitely that if it changes, the change is very gradual when the rate of exposure remains the same as during the preceding two years. Hence it is safe to use this as a criterion of protection.

The radiologist who, from the nature of his work, must handle radium for an indefinite period of years, should be extremely careful *from the very beginning* and at all times. The novice is almost always careless and somewhat reckless. Only too often the realization of danger comes after irreparable damage has been done to his fingers. With the knowledge available at present, this is entirely inexcusable. The average radium therapist can arrange his work and technic in such a way as not to exceed the safe limits of exposure of his fingers.

(b) *Individuals Exposed to Radiation for a Definite Period Only*.—This refers to technicians, assistants, and internes who are required to handle radium for a definite period not exceeding one year, and who do not plan to work with radium afterwards.

In this case the exposure can be considerably greater than in the previous one, without danger of permanent local effects. Again, it is difficult to say just how far one

can go. Obviously the criterion of slight reddening and shiny appearance of the skin around the finger nails at the end of two years cannot be used in the case of individuals employed for less than one year. As a working rule we may say, however, that the same degree of effect appearing at the end of five or six months' exposure indicates that the (temporary) technician can safely continue to work with radium *under the same conditions* for an additional six months, so far as *local effects* are concerned. The italicized parts of the above statement are very important. A temporary technician near the end of his term may feel that it is no longer necessary for him to be very careful. Or he may be required to handle more radium, due to changes in technic, increased radium supply, etc. In these cases he is no longer working under the same conditions as previously, the rate of exposure is greater, and one cannot predict what local effects may develop later. It will be seen presently that the local effects of radiation are not necessarily the controlling factors in deciding whether or not a technician may safely continue work with radium. What has been said so far applies only to local effects.

At this point it may not be amiss to recall what the consequences of local over-exposure may be. Throughout the world there have been numerous radiologists and technicians who have lost their fingers, arms, and finally even their lives from over-exposure to X-rays in the early days. There have been several who have run the same course due to over-exposure to radium rays. A recalcitrant X-ray or radium "burn" is very apt to become malignant. Fortunately, however, this does not happen (at least it has not happened in the past) unless there is first an actual breakdown of the tissues following long-continued exposure to radiation. The breakdown need not necessarily be spontaneous, but may be brought about

The writer has been associated with the Memorial Hospital since 1915, during which time he has had the opportunity of observing many technicians who have handled radium for various periods of time. From 1914 to 1917 the Hospital's supply of radium gradually increased to four grams, 3,650 mg. of which was placed in solution for the production of radon. The routine manipulations in the collection, measurement, and distribution of the large supply of radon are considerable, and require special precautions. In 1927 the Hospital acquired four additional grams of radium for use in a pack. The experience acquired during the last sixteen years under these conditions may be used as a guide in formulating certain general conclusions.

The first local effect manifests itself as a reddening of the skin of the fingers near the nails. Later the nails may assume an unusual curvature which, in certain individuals makes the nails slightly concave upward and in others a little more concave downward than normally. Still later (with continued exposure), the nails become somewhat brittle, and have a tendency to crack under slight strain. The skin at the end of the index finger and thumb (which always receives much more radiation than any other part of the hand, particularly through carelessness) becomes somewhat leathery and may lose its characteristic ridges. Finally keratoses may appear.

We have had technicians who have remained with us from a few months to several years. Many of these have come back at intervals for friendly visits and we have had the opportunity to examine their hands for several years after they left the Hospital. We have found that recovery takes place slowly, the time required for a return to normal depending on the degree of effect initially present, the type of skin (whether moist or dry), and the type of manual work done in the interim. Technicians who had

developed keratoses have shown definite radiation effects several years later, but there has always been a distinct improvement with time.

Although some technicians show radiation effects sooner than others, it is difficult to attribute this definitely to a difference in sensitivity. Some are certainly much more careless than others. We have had no evidence of any idiosyncrasy to radiation. Since skin tends to become dry under the influence of radiation, a moist skin is an asset. It is important to note that, barring sheer carelessness on the part of the technician, the skin of the hands undergoes these changes very gradually. Furthermore, we have had no technician whose irradiated skin became worse after leaving our employ; on the contrary, there has always been an improvement.² It follows, therefore, that the condition of the skin of the fingers may be used as a practical criterion for the protection of technicians from the *local* effects of radium rays. As a safe rule, we may say that if at the end of two years the radiation effects on the hands are limited to a slight reddening and shiny appearance of the skin around the finger nails, the technician may *probably* continue to work with radium indefinitely under the same conditions, *insofar as local effects are concerned*. If gradually more marked effects appear, the technician should decide to give up radium work, either permanently or for a number of months. In view of the slowness of recovery from these local effects, a vacation of reasonable length is of little benefit.

It may be well to emphasize at this point the assumptions which underlie the above conclusion. In the first place, it is assumed that the technician's hands are exposed practically every day and that the quantity of radiation received by the fingers is about the

²Since we have not seen all technicians after they have left our employ, this statement is based on the condition of the skin of those we have seen and the assumption that, if any complications had developed, we would have been so informed.

technic, hour of day, etc.), one can obtain a fair idea of what constitutes a "normal" blood count for the individual under consideration, before radiation changes may be expected to be present.

In interpreting the results of the blood tests, many factors must be taken into account, but if there is a definite trend downward for the white count over a period of a few months, the technician should be subjected to a thorough physical examination. His working conditions should also be investigated. What steps should be taken after this depend on the findings and on a number of circumstances.

If several other technicians working under the same conditions have not shown like blood changes in the same or longer periods of time, the drop in the white count is probably due to causes other than exposure to radium. The physical examination and the blood count as a whole may reveal the cause. If no plausible explanation can be found, it is safest to assume that the radiation is at least partly responsible for the changes noted, and the technician should then refrain from working with radium³ for a month or longer to see whether or not the blood count returns to normal quickly. During this period it is desirable to have blood counts made every two weeks, in order to obtain a better average. The writer has no definite knowledge of the time required for the white count to return to normal after it has been lowered by exposure to radiation. This must depend on many factors, and particularly on the period of time during which the technician has been exposed to radiation (whether months or years). At any rate, a vacation of a few weeks usually is not sufficient.

Judging from the number of persons throughout the world who must have been

over-exposed since radium has been used extensively, and the small number of casualties from constitutional effects, one may conclude that the human body is capable of withstanding considerable amounts of radiation over a long period of time. Here again a sort of equilibrium may be established, after a certain time, involving the accumulation of daily doses, the latent period, the rate of recovery, and the degree of effect present. Whether such a state of equilibrium can exist when the white count is definitely lower than the normal value, without impairment of the vitality of the individual, is not known. It is really a question of the significance of a low white count brought about by exposure to radiation. The writer (a layman, as mentioned above) is of the personal opinion that a *slightly subnormal* white count due to exposure to radiation, does not connote the same degree of lowered vitality that a similar condition indicates in non-irradiated individuals. For instance, radium technicians with a depressed white count do not seem to be subject to colds to any greater extent than other persons working under analogous conditions. But in view of the lack of definite information on this point, the seriousness of the possible complications, and the relative ease with which sufficient protection can usually be provided, there is no reason, from now on, for allowing the white count of a technician to become definitely subnormal. With careful blood tests made every month, it is not difficult to detect the first signs of a downward trend in the white count, erring on the side of safety if in doubt.

In the case of a radiologist or a physicist who cannot readily drop his work with radium, the question of constitutional effects is extremely important. He should ascertain from the start that he is working under the proper conditions to insure safety. The blood count criterion may not be delicate enough in this case, although there is no

³It is assumed that there is no possibility of simultaneous exposure to X-rays. If the technician's duties include work with radium and X-rays, it will be well to check up also the X-ray protection in the laboratory.

by mechanical injury of the over-irradiated tissue, which has a low vitality and a tendency to become infected.

In view of the risk involved, it is the personal opinion of the writer (who is a layman) that a finger with a refractory radium "burn" which shows no tendency to heal six months after its inception, should be amputated without further delay. Amputation may be desirable sooner if the "burn" tends to progress. In any case, enough tissue should be removed to insure prompt healing of the operative wound. The tissue removed should be subjected to a careful histologic examination.

2. GENERAL OR CONSTITUTIONAL EFFECTS

The gamma radiation of radium is so penetrating that a block of lead 25 cm. thick is unable to stop it completely. To be sure, the intensity of the transmitted radiation in this case is extremely small, and certainly below the tolerance limit, even if the amount of radium behind such a shield is large. But in practice it is impossible to carry out manipulations with radio-active substances without being exposed to gamma radiation of appreciable intensity. Lead screens of practical dimensions, and distance from the source, help tremendously in reducing the intensity of radiation, but nevertheless the operator's entire body receives some radiation.

The physiologic changes brought about by continuous exposure of the entire body to radiation are rather obscure. It is definitely known, however, that the blood picture changes, and that the white count in particular is a rather sensitive index. Extreme over-exposure in a few cases has resulted in the development of anemia or leukemia which subsequently proved fatal. Thus the complications which may be brought about by constitutional effects are apt to be much more serious than any local burn; hence, much greater care must be exercised.

The local effect on the fingers of a technician cannot be used as a criterion of the degree of general effect. A very careful operator will show no skin changes in his fingers for a long time, but the protective measures against general irradiation in the laboratory or office may be inadequate and the "body dose" will then exceed the tolerance limit in a rather short time. This statement should not be taken to imply that the body dose which a technician receives is independent of the care he exercises in handling radium. A careless operator will obviously get more radiation, both locally and throughout the body, but he is more apt to show local effects first. On the other hand, no matter how careful a technician may be, if he is required to stay regularly in the vicinity of radium with insufficient protection, he will eventually show some constitutional changes.

In general, blood counts are not very satisfactory; variations may be introduced by the technic employed. Normal fluctuations of considerable magnitude are always present over a period of time. The count may change according to the hour of the day when it is taken (*e.g.*, before or after a meal). Furthermore, the absolute white count of normal individuals varies within wide limits. Six thousand white cells per cubic millimeter may be normal for one individual, and nine thousand for another; accordingly, it is impossible to set a fixed lower limit for the white count of radium workers as a danger signal. Nevertheless, under proper conditions and wise interpretation, the blood count can be used as a safety criterion.

With our present knowledge of protection, and the amounts of radium usually available, it is not likely that a technician will receive too large a body dose in a few months. If blood counts are made *before he is employed* and every month subsequently, always under the same conditions (same

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ence has been made to the so-called "radium
poisoning" which has attracted considerable
attention in recent years. The reason for
this is that there is no such danger at all in
the handling of radium which is *sealed* per-
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poisoning" is due to the slow ingestion of
minute quantities of radio-active materials.
Radium used for the treatment of cancer is
always in sealed containers, and there is
no possibility of ingestion by the technician.

The only danger to be guarded against in
this case is from the effects of over-exposure
to radiations emitted by radium.

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Recommendations as to the value of the
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vestigators. Mutscheller (3) and Sievert
(4) suggest 0.01 erythema dose in 30 days.
Farley and Cox (5) recommend 0.0084
and The Dutch Board of Health (6), 0.002
erythema dose in one month. Bouwers and
van der Tuuk propose not more than 0.01
erythema dose per month. These figures are
considerably higher than the one advocated
by us for gamma rays. The actual intensi-
ties are probably still higher than the figures
indicate, on account of the uncertainty of
the erythema dose which was adopted by
us as the unit. In our case the unit is
the *threshold* erythema dose, which, as al-
ready stated, corresponds to 600 r of X-ra-
diation.

It is conceivable that the human body can
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be employed tentatively, but another blood test should
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to determine whether he is

evidence to the contrary. For this reason it is very important to have some definite knowledge of the tolerance intensity under these conditions (irradiation of the whole body during a period of years). Some valuable conclusions may be drawn from our experience with the four-gram radium pack at the Memorial Hospital.

3. ESTIMATION OF TOLERANCE INTENSITY

The pack and the protective measures provided have been described in detail in a previous publication (1). For our present purpose we may recall that the radium is surrounded by 10 cm. of lead, effectively limiting the beam of gamma rays to be utilized. Means are provided for "shutting off" the beam while the pack is being adjusted to the patient. Heavy lead plates are distributed in tactical positions for the purpose of confining the scattered radiation. The pack is in use twenty-four hours a day, and three technicians, each on eight-hour duty, attend to it. The technician stays in an adjoining room at a distance of about 5.5 meters from the radium. One technician has been in constant attendance since April, 1927, another since September, 1928, others for shorter periods. There have been some fluctuations in the blood counts of these technicians within normal limits. No detectable trend in either direction has been noted. It may be inferred, therefore, that the intensity of gamma radiation to which they have been subjected during the elapsed time (a maximum of four and one-half years), is below the tolerance limit.

It is possible to determine this in a rather simple way (2). The method has been described by Mrs. Quimby, and the details need not be repeated here. The technician carries a photographic film continuously for a number of days. The amount of blackening is then compared photometrically with that of a series of films exposed to known amounts of radiation, and developed simul-

taneously with the test film. In this way it is possible to determine the amount of radiation which is responsible for the blackening produced on the technician's film, and, therefore, the average intensity of radiation to which the technician is exposed. It is very important to note that the same quality of radiation must be used in making the comparison standards, as reaches the technician. If the standards are made by exposure to X-rays, large errors are introduced. For instance, using ordinary deep therapy X-rays in making the standards, the intensity of gamma radiation to which the technician is exposed appears to be about one-tenth of what it actually is. As an additional precaution, all films used should be cut out of the same large film and should be developed simultaneously under the same conditions.

This test has been made by Mrs. Quimby in the case of our radium pack technicians on two different occasions, separated by an interval of two and one-half years, the two determinations checking within 5 per cent. While such a close agreement is probably accidental, we may say with considerable assurance that the method is certainly sufficiently reliable for all practical purposes. The results show that these technicians receive approximately 0.001 of a threshold erythema dose per month. In order to avoid any possible misunderstanding it may be well to add that the threshold erythema dose taken as our unit *corresponds to 600 r of X-radiation*. In view of the uncertainties still existing in the measurement of gamma rays in roentgens, it is best for the present not to express quantities of gamma rays in terms of the international unit of X-radiation.

As already stated we have had two technicians who have been exposed to this intensity of radiation for four and one-half and three years, respectively, without showing any blood changes. It is probable,

therefore, that the human body as a whole can be subjected to this intensity of gamma rays indefinitely without showing any deleterious effects. It may be that a considerably higher intensity would also be harmless, but we have at present no very definite data to support this view. Accordingly, it is preferable to use the above value of 0.001 threshold erythema dose per month as the tolerance intensity of gamma rays to which a technician can be exposed continuously for a number of years. It is best in this case to speak of a "tolerance intensity" instead of a "tolerance dose" because we are considering technicians, physicists, and radiologists who expect to work with radium for an indefinite period of years, perhaps a lifetime. If the exposure is limited to one or two years, the intensity can undoubtedly be much greater.

Recommendations as to the value of the tolerance intensity in the case of X-ray workers have been made by different investigators. Mutscheller (3) and Sievert (4) suggest 0.01 erythema dose in 30 days. Barclay and Cox (5) recommend 0.0084 and The Dutch Board of Health (6), 0.002 erythema dose in one month. Bouwers and van der Tuuk propose not more than 0.01 erythema dose per month. These figures are considerably higher than the one advocated by us for gamma rays. The actual intensities are probably still higher than the figures indicate, on account of the uncertainty of the erythema dose which was adopted by some as the unit. In our case the unit is the *threshold* erythema dose, which, as already stated, corresponds to 600 r of X-radiation.

It is conceivable that the human body can tolerate a higher intensity of X-rays than gamma rays, especially if the measurements are made on the surface of the body. On account of the greater penetration of gamma rays, the internal organs would receive more radiation than in the case of X-rays, assum-

ing equal intensities at the surface. The difference, however, cannot be very marked unless gamma rays are differentially more active than X-rays with respect to some body tissues. Since protection from ordinary X-rays can be provided much more readily than in the case of radium, we would suggest that the same tolerance intensity of 0.001 threshold erythema dose per month be used in both cases. This applies to the protection of radiologists, physicists, and technicians permanently engaged in radium or X-ray work, insofar as constitutional effects are concerned.

4. SELECTION AND SUPERVISION OF TECHNICIANS

Before employing a technician for radium work, a complete blood count should be made. If there are any abnormalities which cannot readily be accounted for,⁴ it is best not to employ him. Individuals in good physical condition should be given preference. It might be well also to consider the nature of previous employment. A boy who is accustomed to working out-of-doors is apt to show some blood changes after being confined in a laboratory, whether he handles radium or not. The applicant who has led a sedentary life and is in good physical condition might be given preference.

The prospective technician's hands should be examined carefully with the idea of estimating (1) the quality of the skin, and (2) the care he takes of his hands. A moist, pliable skin is to be preferred. A delicate skin is not so suitable for radium work. Dry skin with a tendency to crack or skin with warts should be avoided. A man whose hands show signs of abuse (cuts, cracks, grease from handling machinery, etc.) should not be employed. He is apt not to take proper care of his hands under any

⁴An applicant may have a cold, in which case the white count may be somewhat high. If such is the case, he can be employed tentatively, but another blood test should be made two weeks later and at the end of one month, to determine whether he is suitable.

circumstances. There does not seem to be much difference (if any) in skin sensitivity so far as the hands are concerned, between "fair" and "dark" individuals. Perhaps a dark skin is preferable.

Manual dexterity is a great asset to a radium technician, since the more rapidly all manipulations are carried out, the less the exposure. It is difficult to predict from an interview just how adept the technician will prove to be. The training and previous occupation of the applicant, as well as the career he wishes to follow, may be used as a basis. One who has had some experience can usually pick out at a glance the awkward, slow, and careless individual. The reverse is more difficult, but, at least, one can avoid selecting the worst.

Before the technician is employed he should be told very definitely about the possible dangers of radium work. We always follow this procedure, and it is only rarely that the applicant decides not to accept the position. Permanent employment should never be promised. In fact, it should be definitely stipulated that the technician is to leave if for any reason the employer decides that he is not suitable. Similarly, the technician should have the privilege of leaving at any time, but should give notice of his intention to do so two weeks in advance. A technician who wishes to change his occupation should not be induced to stay. He is apt to be dissatisfied later.

After the technician is employed he should be instructed thoroughly regarding the procedure to follow in order to reduce to a minimum the exposure in carrying out the required manipulations. Usually, close supervision is necessary in the beginning to make sure that he is taking full advantage of the protective measures provided in the laboratory. It is essential to impress the technician with the importance of distance, rapidity of manipulation, and shielding.

Frequent examination of the technician's

hands should be made, at least during the first six months. There should be no evident skin changes in this time. If there are, steps should be taken to determine the reason and then act according to the plan previously outlined. Technicians should be instructed and urged to take proper care of their hands, especially in winter. A liberal use of ordinary "hand lotion" is very desirable. Lanoline rubbed into the skin at night seems to be excellent, particularly for dry skin.

Complete blood counts should be made every month and the data should be filed for a permanent record. We have found it best to let our technicians see the results of the blood counts. In this way they know just what is going on, and they are free to consult their family physician for advice, in case there is any doubt in their mind. A complete blood count consists of the following determinations: Hemoglobin test, red, white, and differential counts, the latter including percentages of polymorphonuclear cells, small and large lymphocytes (separately), eosinophils, and basophils. The first indication of radiation effect is given by a drop in the white cell count below the normal average for the individual under consideration. Later, but only in some instances, the differential count may show some abnormality. That is, the percentage of polymorphonuclear cells may be lower, and the percentage of small lymphocytes correspondingly higher, than in previous counts. Whether this change can be attributed to radiation is not definitely known. At any rate, its appearance should be taken as an indication for greater caution and an investigation of the technician's physical condition. The blood count should be repeated immediately to make sure that there has been no technical error, and also in about two weeks' time, to determine whether the effect persists. In the latter case the technician should be relieved of his duties temporarily or permanently, depending on the results of

subsequent tests. If at any time the white count shows a definite trend downward, the steps previously outlined should be taken.

Permanent radium technicians should have six weeks' vacation a year, preferably four weeks during the summer and two weeks in winter. They should be urged to spend as much time as possible out of doors, both during their vacation periods and after working hours. Rooms in which radium manipulations are carried out should have outside windows, or should be properly ventilated. A suitable room or space should be provided where technicians may spend their time when they are not handling radium; this should be located as far as possible from rooms where radium is stored or patients are treated.

It is difficult to state the number of technicians that should be employed to handle a certain quantity of radium. A great deal depends on (1) the therapeutic technic employed, (2) the number of patients treated for whom applicators must be prepared, (3) the protective devices employed, (4) the permanency of the technical personnel, and, of course, (5) the amount of radium available. It is always preferable to have only temporary technicians for the bulk of the work. If several technicians are necessary, one may be employed permanently to supervise the work of the others and to carry out some of the more difficult manipulations.

If the safety criterion for local and constitutional effects given in this paper are followed, the dangers of radium work can be

avoided. It should be noted that no reference has been made to the so-called "radium poisoning" which has attracted considerable attention in recent years. The reason for this is that there is no such danger at all in the handling of radium which is *sealed* permanently in metal containers. "Radium poisoning" is due to the slow ingestion of minute quantities of radio-active materials. Radium used for the treatment of cancer is always in sealed containers, and there is no possibility of ingestion by the technician. The only danger to be guarded against in this case is from the effects of over-exposure to the radiations emitted by radium.

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PROTECTION IN DIAGNOSTIC ROENTGENOLOGY: AVOIDING THE DANGERS OF X-RAY EXPOSURE AND HIGH TENSION SHOCK¹

By W. EDWARD CHAMBERLAIN, M.D., PHILADELPHIA
From the Department of Radiology, Temple University Medical School

THERE is no essential theoretic connection between protection against X-ray exposure and protection against high tension shock. Let us, therefore, consider these two matters quite separately, al-

against the biologic action of X-rays used in diagnosis. Some hold that the quantities and qualities of these rays are such as to render drastic protection unnecessary; others feel that it is impossible to overdo this type

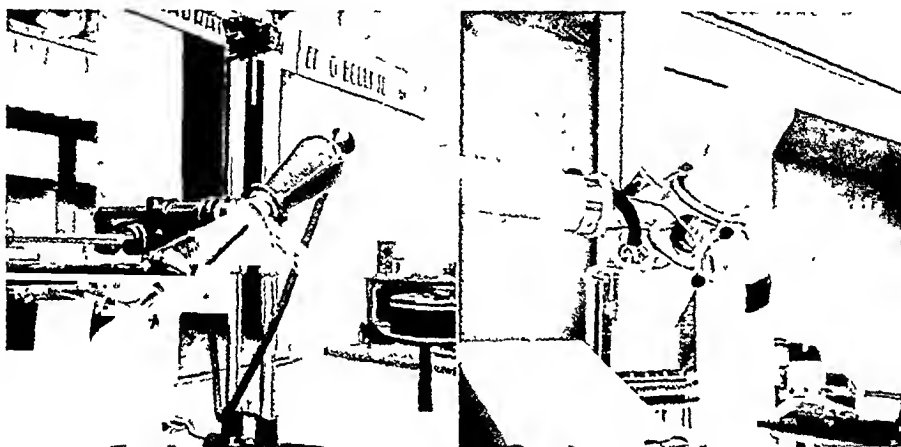


Fig. 1 (left). A Metalix "autoprotective" tube is made shock-proof by enclosure in this metal shield. Air, bakelite, and rubber enter into this design. Anode cooling is by means of water, pumped through the anode (insulated) cable. This design may be had in various sizes, according to voltage requirements (cf. Fig. 4). All sizes are perfectly flexible and very compact, and, owing to the fact that the built-in X-ray shielding of the Metalix tube is ample, and is obtained with a minimum mass of lead, close to the X-ray source, the total weight of this shock-proof assembly is remarkably low. Originally designed for therapy, this design is now being manufactured for diagnostic work.

Fig. 2 (right). A ray-proof and shock-proof tube shield of recent European design in which perfect flexibility is combined with remarkable compactness. A novel method of preventing the accumulation of excessive negative charges upon the inner surface of the cylindrical glass vacuum chamber has enabled this manufacturer to enclose his tube in a close-fitting porcelain jacket. The outer surface of this porcelain jacket is metalized and grounded. The high tension is admitted by way of rubber-insulated cables. The anode cable carries tubing through which oil is pumped for anode cooling. The use of oil for this purpose greatly simplifies the insulation of the cooling system.

though it will shortly appear that in practice there are many points of contact between the two problems.

BIOLOGIC EFFECTS

There is a difference of opinion as to the necessity for drastic protective measures

of protection—that no avoidable exposure should be tolerated.

Our own opinion is colored by the unfortunate experience of having had one of our best and most efficient technicians develop an anemia which made a change of vocation necessary. Most of this technician's work was done in a radiographic room which was

¹Read before the Seventeenth Annual Meeting of the Radiological Society of North America, at St. Louis, Nov. 30-Dec. 4, 1931.

rather small. The operator's booth carried the conventional "4-pound lead" walls, with an excellent lead glass window, but there was no roof. The back wall of the booth was of wood, glass, and plaster. After the

could we be convinced that the technician's anemia was really caused by X-rays. After we had satisfied ourselves that the protection was inadequate, we made the following changes: a roof of 4-pound lead was added

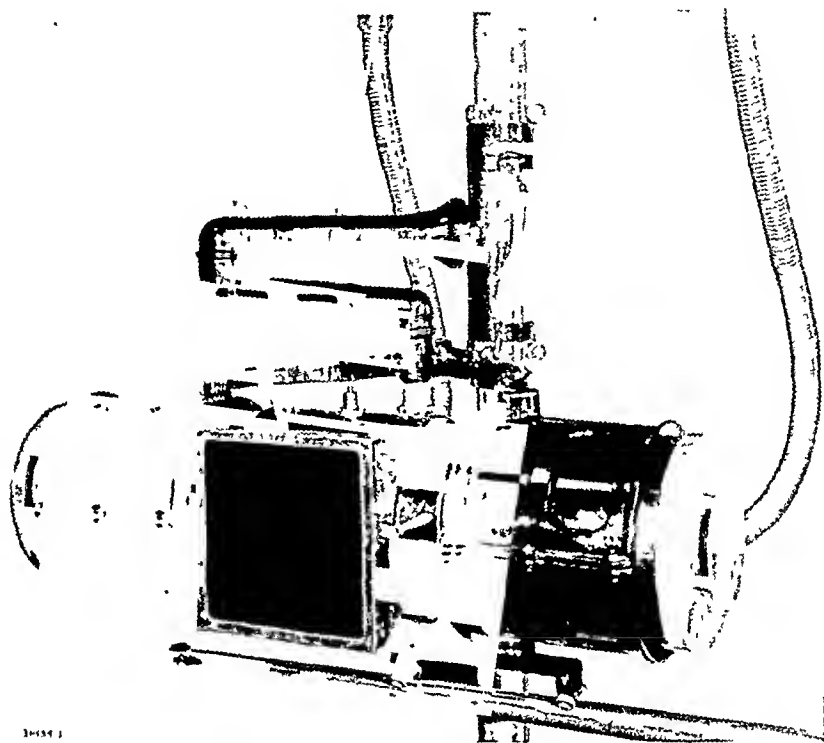


Fig. 3. This recent American design consists essentially of a grounded metal drum, to which the high tension is conducted through ground-shielded, rubber-insulated cables. Ample air space and efficient ventilation enable the use of radiator tubes. For old style X-ray tubes this drum must contain lead shielding, making its weight rather formidable. Used with "autoprotective tubes," such a shock-proof shield need not be so heavy. Note the shutter handles, which control shutters for fluoroscopy.

damage had been discovered, we readily established the fact that, when the X-ray tube in this room was excited, a considerable quantity of X-rays entered the operator's booth by being scattered back from the ceiling and the rear wall of the booth.

The protection, which was thus proven to be inadequate, was quite the equal of the average conventional installation. Only after a painstaking study of all the data

to the operator's booth. The back wall of the booth was covered with lead. The Coolidge tube in its conventional "open lead glass bowl" was replaced by a Metalix "autoprotective" tube. These changes cut down the radiation reaching the operator's position to a barely measurable fraction of its earlier value.

It is obvious that we believe in the greatest possible care to avoid every unnecessary

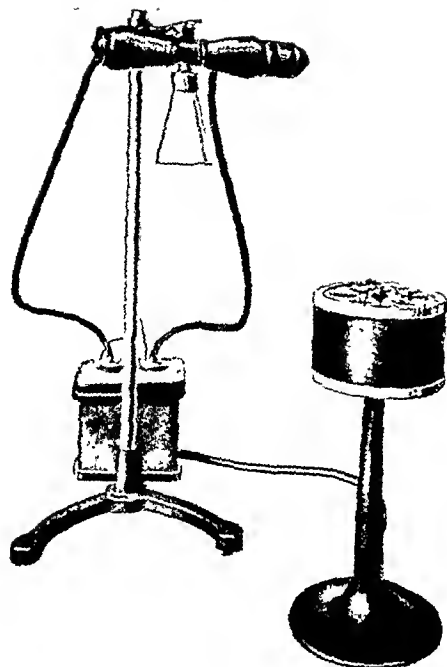


Fig. 4. A Metalix (autoprotective) tube is completely enclosed within this grounded metal shield (cf. Fig. 1). A small air blower cools the anode radiator. The high tension conductors are rubber-insulated and are enclosed within grounded flexible metal shields. Recent developments along these lines have made it possible to build such ground-shielded rubber-insulated cables for any voltage which could conceivably be required in diagnostic roentgenology. Even therapy voltages have been successfully dealt with.

exposure of patient, technician, and physician. For the sake of brevity, we shall simply list the various measures which have proven of value toward this end.

PROTECTION OF PATIENT

1. *Proper Filters.*—It is easy to establish experimentally that, for each radiographic procedure, a certain definite thickness of filter (usually aluminum) can be used in the beam without noticeable effect upon the density or contrast of the resulting roentgenogram. By using such an optimum degree of filtration, we are cutting the biologic effects upon the patient down to a minimum.

2. *Proper Cones.*—Too often one sees the entire patient "in the beam" while a 2-

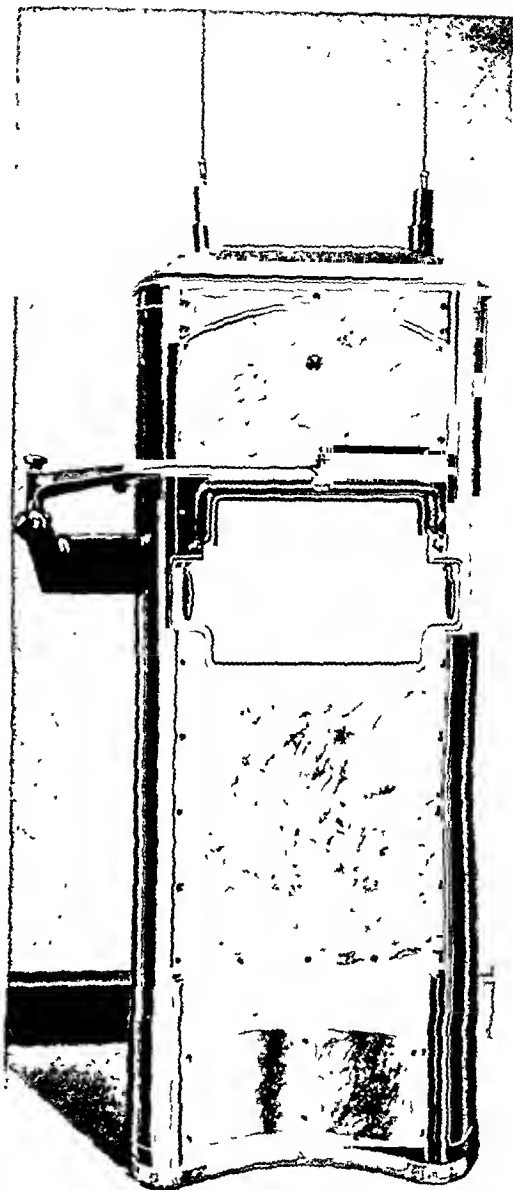


Fig. 5. This recent product of a well known American manufacturer shows how readily the ordinary vertical fluoroscope can be made entirely shock-proof. In this unit, the tube, cord reels, and conductors are all enclosed in a metallic shield or housing, which may also contain the transformer, if desired. The high tension "masts" are used when this fluoroscope is connected to an external source of high tension.

meter chest film is being exposed. Proper coning will cut down the biologic effects upon the patient, as well as the scattered X-

rays in the room, incidentally leading to some improvement in the roentgenogram.

3. *Proper Enclosure of the X-ray Tube.*—The closed lead glass container is much better than the open tube bowl. Best of all

4. *Maximum Feasible Distances between Patient and Tube.*—A moment's calculation will prove to anyone that, along with the decrease of distortion in a teleroentgenogram, there is a decrease in skin effect for unit film

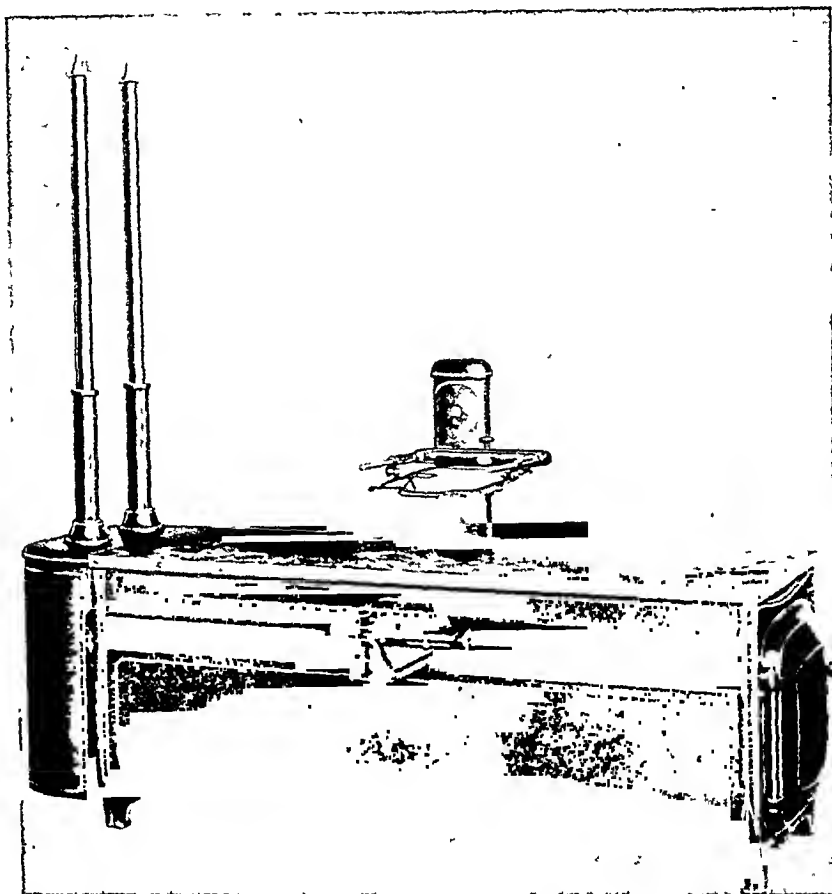


Fig. 6. Like the vertical fluoroscope of the same make, this horizontal fluoroscope has been rendered completely shock-proof by enclosing the tube and conductors in a grounded metal housing. The simplicity of this method of "shock-proofing," and the fact that the usefulness of the apparatus is not in any way interfered with, would seem to corroborate the author's contention that fluoroscopy without complete electrical shielding is no longer justifiable.

are the "autoprotective" tubes such as the Metalix, in which lead sleeves and electrodes are arranged to allow no important amount of ray to leave the tube except in the direction of the useful beam. "Autoprotective" tubes and devices of American manufacture, which have just been announced, give promise of being equal to the best.

density. Especially in fluoroscopy has this distance factor been neglected.

PROTECTION OF TECHNICIAN AND RADIOLOGIST

1. Since the scattered rays from the patient, etc., are cut down by filtration, cones, or diaphragms, and proper tube enclosure,



Fig. 4. A Metalix (autoprotective) tube is completely enclosed within this grounded metal shield (cf. Fig. 1). A small air blower cools the anode radiator. The high tension conductors are rubber-insulated and are enclosed within grounded flexible metal shields. Recent developments along these lines have made it possible to build such ground-shielded rubber-insulated cables for any voltage which could conceivably be required in diagnostic roentgenology. Even therapy voltages have been successfully dealt with.

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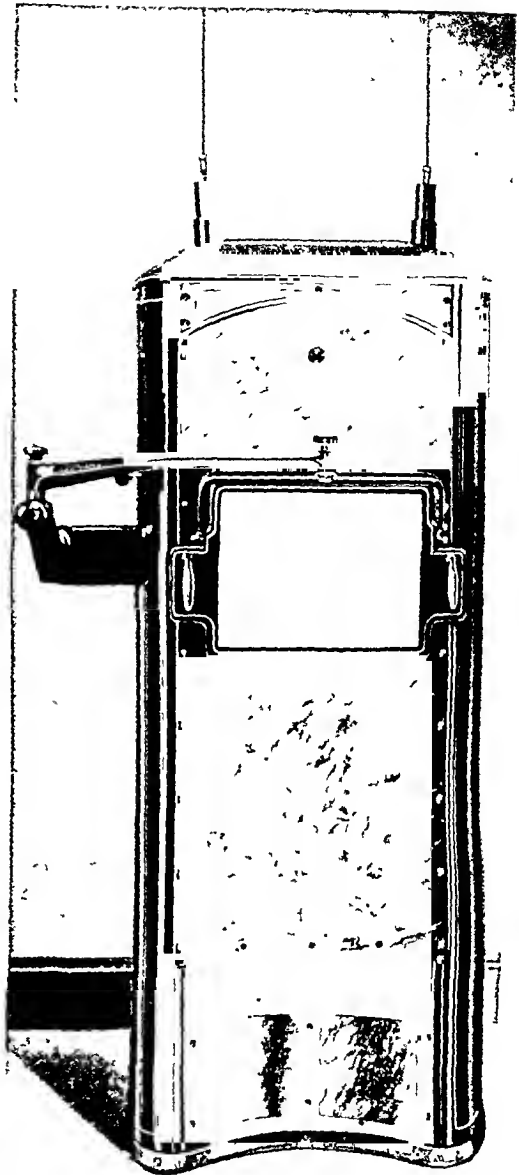


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meter chest film is being exposed. Proper coning will cut down the biologic effects upon the patient, as well as the scattered X-

opportunities and responsibilities along these lines must be apparent to anyone who inspects the Technical Exhibit at this meeting. There seems no limit to the degree of safety attainable, once we make up our minds it is desirable. We believe that this development of protection against electric shock will not stop until all high tension is safely shut in. Protection against biologic effects will never

reach this level, but it is already accomplished to the necessary degree in every modern roentgen laboratory, and is rapidly improving elsewhere.

SUMMARY

This paper is a brief résumé of the theory and practice of protection (as applied to di-

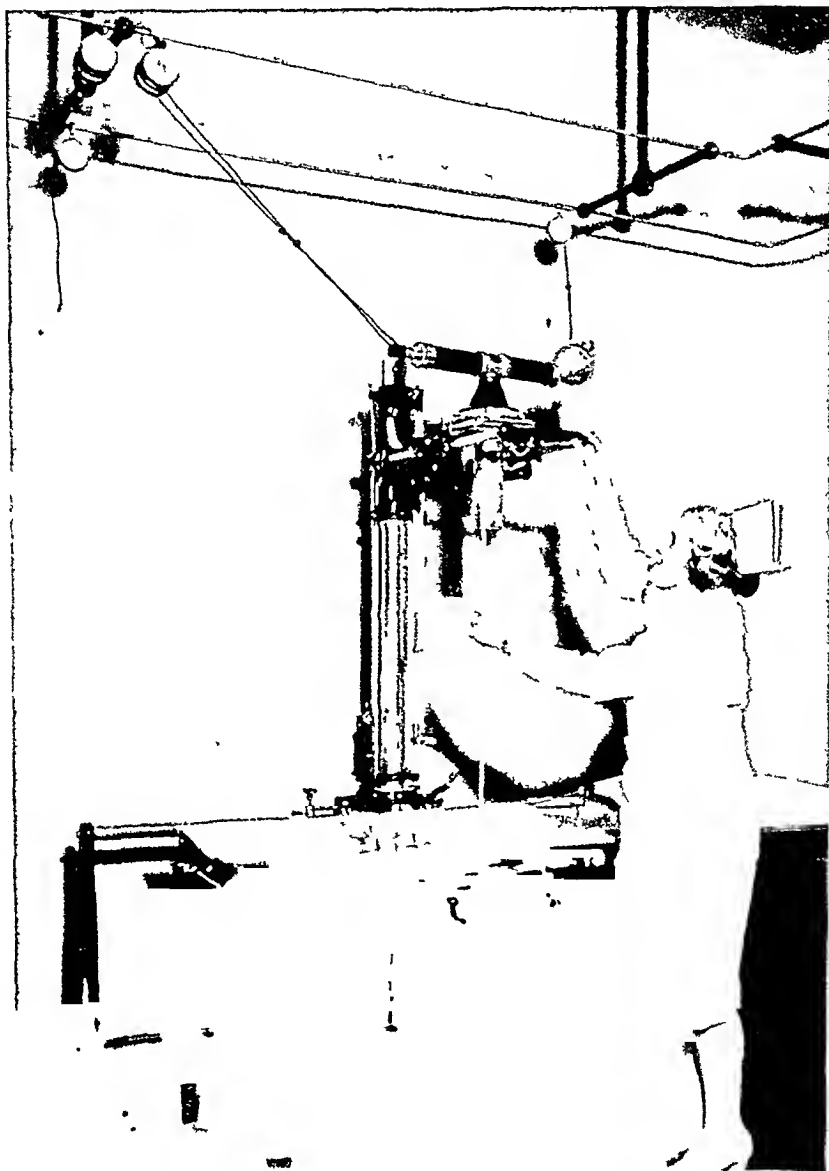


Fig 8 This specially built table contains a curved type Potter-Bucky diaphragm with 48-inch radius of curvature. With tube at top of tube-stand travel, the target-film distance is 53 inches. This minimizes distortion and increases detail. Owing to the great distance of all the conductors above the floor, this installation is practically, though not theoretically, "shock-proof."



Fig. 7. This home-made shock-proof bi-plane fluoroscope was built by the author and his Research Engineer, Mr. O. C. Hollstein, for the Chevalier Jackson Bronchoscopic Clinic. The tube for the horizontal ray is behind a partition. The ray comes through the aluminum panel. The target-screen distance is 4 feet. The tube and screen move together, being mounted on the same framework. In a later model which we recently built for another hospital, the oil-immersed vertical-ray unit was replaced by a Metalix tube mounted beneath the floor. We believe that in many instances the future will see X-ray tubes mounted beneath floors, behind walls, and above ceilings.

much that is done to cut down exposure to the patient is of great value toward protecting the operator.

2. Large rooms are safer than small ones. If the radiographic room is small, the operator's booth must be the more carefully designed and protected.

3. Detailed specifications of thickness, quality and location of lead glass, metallic lead, etc., are not given here, because these are fully covered in Handbook No. 15 of the United States Bureau of Standards, and in the report of the Advisory X-ray and Radium Protection Committee, published in RADIOLOGY

HIGH TENSION

The complete safety of everyone, patient, technician, and radiologist, from the possi-

bility of high tension shock, is attainable, though fraught with difficulty. Various methods which have been used successfully are:

1. Immersion of the X-ray tube in the same oil tank with the high tension transformer.

2. Placing the tube in a grounded metallic drum or other enclosure, with insulated and ground-shielded conductors (Figs. 1, 2, 3, 4, 5, and 6).

3. Placing the X-ray tube and transformer behind a partition in an ample enclosure, or in a separate room, with an aluminum or bakelite panel to allow the X-rays to enter the radiographic room. This arrangement is perfectly feasible with all forms of teleroentgenography and telefluoroscopy, and we believe that the roentgen laboratory of to-morrow will make frequent use of this arrangement. Most apparatus for roentgenography of the thorax is so arranged that it would be a relatively simple matter to place the patient and film in a separate room from the X-ray tube.

We have had personal experience with bi-plane fluoroscopy at a target-screen distance of 4 feet, with the horizontal ray tube behind a partition, and with the vertical ray tube beneath the floor (Fig. 7).

4. Relative, though not absolute, safety is attained by a suitable increase of the target-film distance, when roentgenographing with the tube above the table. For example, a great deal of radiography in the writer's department is done on a 4-foot-radius Potter-Bucky diaphragm table, using 53 inches from the focal spot to the film. With this arrangement, the high tension is so high above the table and floor that it is all but impossible for the patient, or anyone else, to reach it (Fig. 8).

PRESENT STATUS IN PRACTICE

That the American manufacturers of X-ray apparatus are keenly awake to their op-

LEGAL AND INSURANCE ASPECTS OF PROTECTION IN RADIOLOGY¹

By H. F. WANVIG, NEW YORK

IT is an accepted fact that the use of the roentgen ray in the practice of medicine embodies hazards peculiar to the specialty, in some respects, more severe than those in other departments of the science. Therefore, any approach to the subject of malpractice claims and insurance should first consider some of the hazards that cause claims and make malpractice insurance necessary.

The hazards fall roughly in two general classes, physical and legal.

The physical hazards include faults, or dangers, in the installation or manner of operating roentgen machines and all other items that have to do with contact with the patient before, during, or immediately following roentgen exposure. It does not seem probable that I can say anything about the hazards of installation or technic that would be more than mere routine to roentgenologists, but there are a few items in this general category which are, I think, worthy of special mention.

Attorneys defending malpractice actions constantly complain of the lack of accurate records upon which to construct convincing defenses. In a malpractice defense, all possible information is required. The defendant must be able to reconstruct in his own mind exactly what occurred. His legal counsel must have precise information upon which to prepare his case and present his arguments, and witnesses for the defense are entitled to exact records so that they can testify with a clear knowledge of the facts. Such information can be obtained only from accurate and complete records made at the time treatments are given. It is not enough

for a doctor to "recollect" what occurred or to rebuild his data by translations from hastily scrawled memoranda that mean little to anyone but himself. To be of greatest value, his notes, which should indicate by their form and make-up that they were prepared at the time of treatment, should be recorded clearly, fully, and accurately. When required, such records can be presented in court as valuable exhibits.

Case records should not only show routine information, covering the setting of the machine, time, distance, volume, intensity of dose administered, protection given to other parts of the body, etc., but should also indicate that the patient was adequately advised, in advance, of the possible result, the necessity of protecting irradiated areas from subsequent infection, and the measures to be employed. If possible, the records should include a written acknowledgment by the patient that he assumed such part of the risk of treatment as is necessarily his. I do not mean releases, which we all know have little or no legal value. Records of this kind have an extraordinary value in court, and the roentgenologist who does not rigidly hold himself and his assistants to the preparation of them is a poor malpractice risk.

Histories of previous therapy are sometimes difficult to obtain. Patients are frequently referred from other departments of a hospital to the roentgen department without a history chart showing what previous roentgen, or medical, treatments have been given. Some patients are forgetful. When discussing their histories, they forget to mention previous exposures for roentgenoscopic examinations or roentgenograms. Others are deliberately untruthful for reasons of their own, usually because they want

¹Read before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov. 30 Dec. 4, 1931.

agnostic roentgenology) of patient, technician, and radiologist, against (A) biologic effects of X-rays, and (B) possibility of electric shock. The necessity for protection is stressed, and methods of accomplishment

are described, with selected illustrations. Recent developments have made it possible to obtain ample protection against biologic effects of X-rays, and complete protection against all electrical hazards.

Biology Influencing Social Science Developments.—Increasing knowledge of biological facts and a growing understanding of the underlying principles that bind them together are changing the outlook of the social sciences and "humanities" from anthropocentric, or man-centered, to biocentric, or life-centered. More and more we are thinking of man as a living being vitally connected with the whole web of living organisms, rather than as a separate and special creature set apart from the rest of the world. The old Latin boast, "I am a man, and I count nothing human as foreign to me," must be revised to: "I am alive, and I count nothing living as foreign to me."

This is the central idea of an address on "Hopes in the Biological Sciences" presented before the meeting of the American Philosophical Society by Prof. William Morton Wheeler, Dean of the Bussey Institute for

Research in Applied Biology, Harvard University.

Some parts of the biologist's program are already on the road to fulfillment, Prof. Wheeler stated, but others encounter difficulties.

"The biologist sees all departments of chemical and physical engineering receiving an ever-increasing, enthusiastic welcome from the public and a more moderate appreciation of those applications of the biological sciences which are concerned with forestry, agronomy, and medicine. . . . The hopes of eugenics are even less promising than were the hopes of evolution during the last decades of the nineteenth century, because evolution was mainly concerned with a re-orientation of human thinking, whereas eugenics, as applied genetics, demands action. Of the eventual success of at least a part of its program, however, there would seem to be every prospect." —*Science Service.*

is one as to which a system of treatment has been followed for a long time, there should be no departure from it, unless the surgeon who does it is prepared to take the risk of establishing by his success the propriety and safety of his experiment."

And, further, the law holds a doctor to his task and responsibility, once he has accepted a patient. A court in which this question was raised said: "When a physician is employed to attend upon a sick person, his employment continues while the sickness lasts, and the relation of physician and patient continues unless put an end to by the assent of the parties, or revoked by the express dismissal of the physician."

By these decisions, we are, in effect, directed by the courts to take notice that a doctor must keep up with the modern developments of his profession; that he may not go beyond such modern developments as have been generally accepted, except at his own risk, and that, once treatment has been undertaken, he must continue his responsibility to the patient until dismissed. These are narrow limits indeed. I know of no other profession or undertaking in which legal liability is so closely circumscribed.

In malpractice cases, a bad result does not, in itself, indicate that the doctor has been negligent, and, therefore, is liable. Judge Taft, before going to the Supreme Bench, forcibly pointed out that the principle of "*res ipsa loquitur*" should not apply to malpractice cases. However, plaintiffs' lawyers constantly try to induce the courts to apply this rule and, in at least two States, courts have ruled that roentgen burns may be taken as "some evidence" of negligence. In time, other States may follow that lead. Regardless of the present clear prohibition of the rule, it is probably a fact that the mere existence of a burn has a prejudicial effect upon the minds of many jurors, and no effort should be spared to correct that attitude when an opportunity is presented.

While the burden of combating unfavorable legal rules and principles rests with the attorneys for the defense, roentgenologists should miss no opportunity to inform themselves regarding these rules in order to be able to give their attorneys the maximum amount of assistance when it is needed, and to guide them in their own practices.

These physical and legal hazards, and many others with which everyone is familiar, have combined to make malpractice exposure a troublesome question for the medical profession and for the insurance companies who issue policies against them. As early as 1921, the companies began to see that the risk of insuring roentgen therapy required a higher rate than did other departments of medicine, but it was not until 1924 that roentgen therapy was excluded from general policies and a higher rate charged. This action put the whole question squarely before the profession and there it rests. Since 1924, there has been little change in the cost of therapy losses, therefore, the insurance rates established at the time have remained unchanged. If these rates are so high as to worry those who buy insurance, it is only because the cost of furnishing it is so high that it worries the companies that sell it. That these rates are high compared with the rest of the profession is apparent, but whether they are excessive, when compared with the cost to the companies, is quite another question.

Insurance rates merely measure the hazards of the risks covered. The hazards of roentgen practice cannot be attacked and modified, or eliminated, by anyone except the roentgen-ray specialist. He can do much to reduce those hazards and we may be sure that insurance rates will quickly reflect any resulting decrease in losses. No real progress will be made until the profession itself takes the whole subject in hand. Insurance companies will help, but they will not lead. So long as they can collect premi-

to check up a previous diagnosis and treatment, or to conceal the fact that they are changing doctors. Some want to increase the amount of their treatment, believing that twice as much roentgen therapy will do them twice as much good. We have a record of a man who underwent treatments from three different doctors. After his death, his family sued the third doctor, but, fortunately, information of the other treatments came to light and the case was won by the defendant. Such cases have made roentgenologists despair of always getting proper information. Yet, however difficult it may be, ways must be found for obtaining accurate histories. As roentgenologists, you know how necessary such information is, and I do not mention the fact with the idea of adding, in any wise, to your consciousness of that necessity. On the other hand, we have had ample cause to wonder if those who have tried to get good histories have always been as successful as they might have been had they used more care in explaining to their patients the vital importance, to them, of reporting all previous roentgen exposures or the use of contra-indicated drugs.

The employment of technicians has frequently been cited as one of the elements that make roentgen work more hazardous, from a malpractice standpoint, than other branches of medicine. An examination of 166 roentgen-ray cases by the legal counsel of the New York State Society shows that 40 per cent of them grew out of treatments given by technicians. While it is probably true that other departments of medicine rely upon nurses quite as much as roentgenologists do upon technicians, the difference appears to lie in the fact that roentgen apparatus is always a more powerful agent for inflicting injury than the ordinary instruments used by nurses in general medical or surgical cases. This suggests that much might be accomplished by a closer and a

greater amount of supervision of the work of technicians.

Under the heading of "Probable Causes," it was found that 42 per cent of the cases were due to over-exposure, caused by errors in technic, setting timing devices, and leaving out filters. Many appear to have been preventable errors. If the profession could devise positive systems of checking filters and setting roentgen machines that would eliminate the careless and preventable mistakes, it would do more toward reducing the malpractice hazards of the specialty than could be accomplished in any other way.

The legal hazards are those that affect the malpractice liability of doctors by statutory law or decisions of the courts. These risks are always present in the practice of medicine in all of its departments. They bear a direct relation to the number of patients treated, the number of treatments, and the care and skill employed, not omitting, of course, the results obtained. Every treatment given imposes upon the doctor a definite obligation, based upon an expressed contract, or one which the law implies. By undertaking treatment, a doctor, in the eyes of the law, represents that he possesses a reasonable degree of skill and learning such as is possessed by the doctors generally in his locality. He is required by law to use that skill and learning, as well as his best judgment and reasonable care, to bring about a good result. Should he fail in any of these requirements and a bad result occur, the law holds him liable.

His undergraduate and interne education are not enough, because the law requires that he keep abreast of the times; that he keep pace with the accepted progress of modern diagnosis and treatment. Having marked the line of his compulsory progress, the law says that he shall not go beyond the accepted methods of modern practice in seeking a cure.

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go on the basis of what might be dangerous for the exceptional person.

Dr. Stenstrom suggested the fluoroscopic screen test for X-ray radiation. That is a very sensitive test, is it not, Dr. Stenstrom? You also mentioned the Geiger counter. I supposed that the Geiger counter was something which belonged only to the trained physicists.

Dr. Failla remarked in regard to control by the white blood count. One of these patients who, Dr. Chamberlain thought, had suffered a persistent and continuing anemia because of too much X-ray given several years ago, showed at times an increased white blood count. I wonder if it is true that the white blood cells will always be injured first. I wonder if it is possible that some intensity and continuation of X-ray may injure the hemoglobin portion of the system and still leave a normal or increased number of white blood cells.

Dr. Failla showed slides of a great number of very ingenious apparatuses for protection from radium as one carries it about the hospital. The hole in a radium container should be made small. A box with 5 cm. lead walls about a 2 cm. hole weighs 20 Kg., but if the hole is 5 cm., it weighs almost twice as much.

I was much interested in your report for concrete in relation to lead absorption for very hard X-rays. Was I right in understanding that your figures indicated a reduction to 1 per cent by 28 cm. of concrete? [Yes.] If with diminishing wave length the mass absorption coefficients tend to become nearly the same for all substances, then for very short wave lengths would we not be wise to go to concrete, which is much cheaper per pound than lead?

The legal aspects are extremely important and extremely difficult. Raids on the treasury are a growing racket. When a surgeon undertakes a difficult operation, the attending risk to the patient's life is recognized and accepted as necessary in order to achieve a cure. But if you or I undertake to treat a patient who has a difficult tumor, and we have the temerity to hope to get a cure, we go after it "hammer and tongs." If the patient shows a red skin afterwards, he begins to talk about suing us.

That is not fair. The remedy is education. If radiologists generally were bold in treating cancer, and precise and careful to avoid accidents, then people would learn, first, that X-ray is potent, and, second, that a reddened skin may be the necessary price of a sufficient treatment.

What Dr. Stenstrom said about under-treatment is one of the most important things that has been brought out here. I truly believe that there are more patients suffering from malignancy who are done harm by under-treatment than by over-treatment. The only chance one has to do a patient the maximum amount of benefit is to give the full treatment. I believe it is a more serious mistake habitually to fail to take full advantage of that only good chance than it is to over-treat a few patients.

In regard to records: they are extremely important. Everything should go down in writing at the time it is done. The courts will not accept mechanical arrangements—only personal evidence. I think it is better to have two persons sign for the presence of a filter than it is to have the filter screwed in. As a matter of fact when you screw the filter in, everyone stops looking to see that it is there, so that if the electrician or the director unscrews it, its absence will not be noted.

As to nurses and technicians, we do turn over a lot of very important jobs to them. If we looked upon our treatment of cancer patients as seriously as the surgeon looks upon his operation on the cancer patient, we would do the whole of it ourselves. It is true that some busy surgeons do turn over to assistants the task of closing up, but how many of us turn over to our assistants the doing of the whole radiation treatment!

It would be ideal if, for every serious case that we have to treat, we could have a consultation with the patient's physician or surgeon in the presence of a member of the family, so that what we have to offer could be brought out exactly—exactly why the surgeon does not undertake surgical treatment, exactly why the physician does not undertake medicinal treatment, and why, then, the treatment is turned over to us; how poor or how good our chance is of clearing up the patient's dis-

ums that adequately pay them for the risks which they assume, they will be content. When adequate rates are no longer available for any particular kind of risk, they will discontinue insuring that risk.

There is a general impression among roentgenologists that use of the roentgen ray by men without proper education or experience is largely responsible for the present so-called high level of rates. However, our records show that only a little over 25 per cent of the X-ray suits filed are against general practitioners or others owning roentgen apparatus who have no special training or experience in its use. Nearly 75 per cent are brought against specialists on account of their own treatments or those given by their technicians or nurses.

SUMMARY

1. Make accurate, clear, and complete records at the time of treatments, taking care to show what information and instructions were given to the patient.

2. Get accurate histories covering all information required, even if you have to press for it. Particularly avoid the perfunctory compiling of histories by unskilled assistants.

3. See that your patients receive and understand proper instructions for the care of irradiated areas, to protect themselves and you. Especially warn them of the dangers of additional exposures on the same, or adjacent areas, until directed by you.

4. Leave as little to your technicians as you can, and supervise that little as closely as you can.

5. If possible, check all settings and filters on every machine for every treatment.

DISCUSSION

R. R. NEWELL, M.D. (San Francisco): Dr. Taylor remarked about the carelessness in covering the rooms with lead and then driving nails through the lead. Sixteen-pound lead with a nail hole every 10 cm. might be no

better than 8-pound lead if the latter had no holes.

As soon as the report of the Committee in regard to protection was published in the journals, I had the report typewritten and photographic copies made of the artificial respiration method and then had it mounted under glass in each of the rooms in which high tension current is exposed.

Dr. Stenstrom remarked about natural irradiation, and Dr. Failla also spoke of the amount of radium in the crust of the earth and figured out an astonishing amount of radium in the walls of the Empire State Building. To be sure, the intensity of that radiation is very small, nevertheless the intensity of radiation is not the whole story because radiation acts in spots, and any radiation at all is capable of producing just as much injury in one spot as more intense radiation. That is to say, when you reduce the intensity of radiation you diminish the number of spots in which it acts on the body, but each spot may be acted upon just as intensely as by very heavy radiation.

Some of the biologists at the University of California carried a culture of fruit flies, I believe it was, over into Twin Peaks Tunnel in San Francisco, where the natural rate of ionization is about twice what it is in the town of Berkeley, and they found an appreciable increase in the rate of mutation in the culture, showing that even small radiation is capable of producing biologic effects.

Dr. Stenstrom's maximum permissible amount of one erythema dose in ten years is in good agreement with American and foreign standards. Some persons have tolerated much more. I recollect one patient whom we treated for Hodgkin's disease from head to foot over a period of five or six months. Dosage totaled about 1,000 r (in the beam) during the six months' time, so that she received double the ten-year quota in half a year. Instead of killing her, it cured her. When she did die, after five years, it was not with aplastic anemia but of recurrent Hodgkin's.

But it is not safe to figure from what one person can stand, or from what ninety-nine persons out of a hundred can stand. We must

go on the basis of what might be dangerous for the exceptional person.

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ease, and how great our chance is of getting a severe reaction to our treatment. Then write that down in the records at the time so everybody will know it has been talked about before a friend or relative of the patient. We cannot do it before the patient himself because so often we are dealing with hopeless disease, and it is not fair to tell a patient that he cannot get well.

When the radiologist has a patient referred to him for *diagnosis*, he is a consultant of the patient's physician; but the radiologist to whom the patient is referred for *treatment* becomes inevitably the patient's own physician. We ought to face that fact and have the courage to shoulder that total responsibility for being the patient's physician when he comes to us for treatment, because that is the way he will look at us.

DR. A. MUTSCHELLER (New York City): I am glad to have this opportunity to contribute to the subject of protection against X-rays, some results of my own experiences.

Dr. Taylor mentioned that from 1928 on we had safety protection rules in some countries. In this country from 1925 on, I published, successively, several papers and presented the last one before this Society with the recommendations that the safety protection dose be proposed at the then forthcoming International Congress in Stockholm, as the unit upon which safety recommendations are to be based. I did that at the suggestion of Dr. Kaye, of the National Physical Laboratory, in Teddington, England, and Prof. Glocker, of Germany, for both these gentlemen, who drafted the safety rules for England and Germany, respectively, had accepted my tolerance dose in their recommendations. In fact, when I visited them in Europe less than a year ago, both asked me whether or not I had found any change necessary in this safety tolerance dose. The Chairman at that meeting, Dr. E. C. Ernst, expressed by his remarks that that would be done.

What is that tolerance dose which was accepted in both these countries, and used as a basis for their safety rule recommendations, and why is it so important to have such a tolerance dose? This tolerance dose was ar-

rived at by measuring the intensity of the stray radiation in several therapy laboratories in this country, which, for a number of years, has been proven to be entirely safe. That is, the operators and the personnel in attendance had been engaged in the work for several years, and there had been produced no detectable injurious effect during these several years.

The result was, that while also allowing a large safety factor, *i.e.*, for at least 50 per cent, there is present in such a laboratory a radiation intensity which amounts in one month to about one hundredth part of an erythema dose. This dose was subsequently checked with doses found by others, and particularly by Quimby and Viol, Fricke and Jacobson, and lastly by Barclay in England. The latter also had measured the dose which he found one particular technician could tolerate without incurring any visible injurious effects. His dose was considerably larger, but after I had corresponded with him and given him my reasons, he agreed that a reasonable safety factor should be applied, and corrected his manuscript accordingly and agreed that it would not be justifiable to make the permissible dose just as large as possible, and that, applying approximately the same safety factor which we had applied, his dose came very close to being of the same magnitude, *i.e.*, one hundredth part of an erythema dose per month.

In other words, this safety tolerance dose has been re-checked in a good many different ways; it has been accepted by European protection committees and used as a basis for their calculations, and there appear to be no indications that a change is indicated at the present time. A short time ago, however, I had a letter from Prof. Glocker, and a reprint in which he recommends that the protection screen thickness of 5 mm. of lead for 200 K.V. radiation might be decreased to 4.5 millimeters. Even if we agree to this reduction, we find that the American recommendations of 4 mm. for 200 K.V. are quite appreciably below the German recommendations. For that reason I submit that the recommendations given in the U. S. B. S. Handbook No. 15 are for insufficient thicknesses of lead for the following reasons: First, for the reason that

the protection afforded by 4 mm. of lead with 200 K.V. radiation is probably not that of one-hundredth part of an erythema dose per month under ordinary working conditions, and second, for the reason that I believe exposure quantities, or exposure times, should be considered to a greater extent.

We have, of course, to deal always with present-day conditions, and the speed of our photographic material and of our intensifying screens has increased so that the actual exposure times for radiographic work have been reduced to approximately one-half of what they were years ago. On the other hand, it seems that fluoroscopic examinations are gradually becoming longer, and that fluoroscopy is being used more and more, so that the time factor, as time goes on, should be re-considered, and, if necessary, taken into consideration in calculating protective screen thicknesses. So, for instance, the lead thickness for protective screens for diagnostic X-ray work could perhaps be reduced, for the reason that even though exposures are made throughout the entire day, the total exposure time probably sums up to less than it did formerly. On the other hand, it seems that the protection at present surrounding fluoroscopic tubes is to a large extent inadequate for the reason that ordinary fluoroscopic examinations last longer than they used to do, and also that our present lead glass coverings are not affording the required degree of protection under the safety rules.

In reading over the protection recommendations printed in Handbook No. 15, I feel that many points, of course, can be elaborated upon, and illustrations can be given that cover the rules laid down. From my own experience, and from having seen many installations throughout this and European countries, it seems that the questions of aeration and ventilation are usually not treated with the care which those subjects deserve. Not only do the protection or sanitation rules demand emphatically that the operator's booth be as well ventilated and airy as possible, but the same also applies to the patient's room, for one of the effective causes of after-sickness is, of course,

the inhalation of vitiated air resulting from X-ray exposures and corona bombardment.

In the same way we find that the question of actual protection is not always viewed from as serious an angle as it should be. For instance, I know of several cases in which serious damage has been done to the hair of technicians because X-rays from the tube fell upon wood structures in the operator's booth, there releasing such large amounts of secondary radiation that several operators lost their hair. Similar injuries were observed in a laboratory in which the floors were not lead lined, and in which, consequently, direct X-rays could be reflected *via* the secondary radiation around the lower edge of the protective wall—serious damage to the feet of one operator resulted. For that reason I have often thought that safety recommendations might be much more detailed, and that every known case of injury should perhaps be kept on record as an example of what may take place if safety recommendations are taken too lightly.

In addition to this I would like to mention the fact that it is so easy to acquire bad habits, such as, for instance, the unknowing exposure of ourselves to X-rays, thereby exceeding the tolerance dose. I believe it has been definitely proven that much can be accomplished if only we will not stand in front of X-ray tubes, or in front of fluoroscopes with the shutters wide open, and so on. For that reason, in addition to the fact that every laboratory director may be anxious to test the sufficiency of his protection, I believe that important question has not been dealt with nor has it been accorded a place of prominence corresponding to its importance—only in one short paragraph on the last page of these recommendations, and I think the text is not described in a manner that makes it really satisfactory.

The recommendations are that a film should be carried by the operator for fifteen working days, and that if, after developing, there is an appreciable darkening, the cause shall be investigated, and eliminated. I can imagine that if a technician is anxious to have a holiday, he can easily stretch a point and fog the film slightly, or over-develop it, or thrust it into

ease, and how great our chance is of getting a severe reaction to our treatment. Then write that down in the records at the time so everybody will know it has been talked about before a friend or relative of the patient. We cannot do it before the patient himself because so often we are dealing with hopeless disease, and it is not fair to tell a patient that he cannot get well.

When the radiologist has a patient referred to him for *diagnosis*, he is a consultant of the patient's physician; but the radiologist to whom the patient is referred for *treatment* becomes inevitably the patient's own physician. We ought to face that fact and have the courage to shoulder that total responsibility for being the patient's physician when he comes to us for treatment, because that is the way he will look at us.

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a warm solution, and thus accomplish what he desires.

The use of a fluoroscope, as recommended on the same page, is really an unsatisfactory method, for it depends to a large extent on the intent of the one who makes the investigation. The same holds true with Geiger counters, which are extremely sensitive, and with which one can count almost anything one may desire. Apparently the only method which is easy to carry out, and at the same time has a reasonable degree of accuracy, is that recommended in 1928. According to that, the technician is to carry a film for one week, then a film of the same kind, and from the same package, is to be exposed to a known irradiation, as, for instance, to one-four hundredth of an erythema dose. The two films are then developed together, and, on comparing their intensities, we are able to compare a definite radiation intensity on the film exposed to a known radiation with the intensity on the film carried by the operator. If the film carried by the operator is darker than the one exposed to the known radiation, then it is definite that the tolerance dose has been exceeded. If, however, the film is lighter, or equal in darkness, then it is an assurance that the protection is adequate, and that the technician does not unnecessarily incur the danger of radiation. Therefore, if this method is properly carried out, it tells us two things: Firstly, whether or not the technician is adequately protected, and secondly, whether or not, by omitting to expose himself to the radiation, the degree of his protection cannot otherwise be improved.

DR. A. U. DESJARDINS (Rochester, Minn.): The one thing that struck me was the statement made by Dr. Stenstrom about the frequent insufficiency of treatment, or lack of thoroughness of treatment. We see patients referred from all over the country, and I venture to say that from 70 to 75 per cent of those who have had previous treatment have had either insufficient treatment or treatment that has not been thorough.

The next point is about recording not only the number of hours and the physical conditions of treatment, but the scheme of treat-

ment; by this I mean not only the number of fields, but the exact location of the fields, the direction of the beams, and everything. This requires an anatomic diagram and careful charting; there is no other way. I find it absolutely necessary and invaluable later in reviewing cases, to get a mental picture of just how the treatment was given; otherwise, I cannot be sure how it was applied. From many years of experience I know that the relation of the different beams to one another and to the patient makes a great deal of difference in the effect of treatment.

One more point is that not every clinical disturbance or change in a technician or radiologist is due to radiation. I do not want to minimize the possibility of danger, for we must be careful and the more careful the better; frequently clinicians, surgeons, and many radiologists regard any clinical disturbance as due to radiation, when there may be no relation between the two. Some four years ago I happened to meet one of my old technicians, who had been away from radiation work for a year and a half. Before this she had been with us for only one year, and before that had had two years of non-radiological work. She had worked about two years with radium. She told me that she had just been examined and her blood count had been found very low. She was told that this was due to radiation. When I asked her about the symptoms, she told me they were chiefly about the head. I then asked, "How about your sinuses? Have you had those examined?" "No." Whereupon, I advised her to have these examined. Infected sinuses were found and after the infection was dealt with, her difficulties disappeared. Her blood count returned to normal in three months.

K. W. STENSTROM, Ph.D. (Minneapolis, Minn.): I might say that those figures on adequate protection given by different men seem to show fairly good agreement. Dr. Newell considered 0.1 roentgen per day as safe and I referred to one erythema in ten years. If we consider one erythema equal to 600 roentgens then my statement would correspond to 60 roentgens per year, or 5 r per month, or about 0.2 per day.

DR. NEWELL: I give 0.1 r per day.

DR. STENSTROM: Dr. Mutscheller found by means of measurement that the radiation in the operators' room amounted to about 0.01 erythema per month in some places. We found experimentally that at our place the dose was somewhat smaller.

Regarding the point that Dr. Mutscheller made that the thickness of lead ought to be increased to 5 mm. when 200 K.V. is used, I agree that the thickness ought to be more than the 4 mm. recommended in the "rules." That means that the sum of the thickness of the lead in the wall and in the tube protection ought to be more than 4 millimeters. It is, however, not enough to make this statement. It is necessary to have the wall covered with lead even if no direct radiation strikes it; but in this case 4 mm. of lead in the wall should be more than necessary, as the scattered radiation is softer than the direct radiation.

J. L. WEATHERWAX, M.A. (Philadelphia, Pa.): Practically everything pertaining to protection has been covered, so I will not go into that at all. But there is one thing that I would like to discuss, and that is with reference to X-ray technicians carrying on treatments.

Throughout almost all the hospitals in Philadelphia, we have organized our technicians and taught them in such a way that they can carry on treatments routinely under the guidance of the radiologist. I work with a great many of these hospitals, and I am sure that the work done by technicians, in setting up the patients and giving treatment, is of as high a quality as the roentgenologist would give himself. The technician has one job to do, and that is to set the patient up according to the way that he or she has been taught to do it.

We have had technicians under the guidance of a radiologist routinely treating patients in our institution for a number of years, and we have never had any trouble whatsoever as far as an X-ray reaction is concerned. We get reactions, and I believe, as Dr. Stenstrom has said, that we must show some degree of reaction if we hope to give the patient sufficient radiation to obtain the desired results. We tell our patients that they will get a skin re-

action, and in the ten years that we have been doing radiation therapy at the Philadelphia General Hospital, we have never had any legal trouble and there is no indication of legal trouble.

DR. I. S. TROSTLER (Chicago, Ill.): From the medico-legal standpoint, I think that one of the most important things that we as radiotherapists should stress, as was brought out by Dr. Newell in his discussion, is to tell a member of the patient's family that we expect to get a skin reaction. Then when we do get that skin reaction they will not immediately rush to the office of a lawyer and start a malpractice suit.

Our records should show that we have made this statement to a relative of the patient, in the presence of a witness. We do not have to inform the patient; but with the exception of cases of malignancy we may as well make that statement in the presence of the patient.

I have talked with over a hundred radiologists in regard to this matter, and have found that when they have made the assertion to the attorney for the plaintiff—in case of such malpractice suit—that they had made such a statement before a witness, to the patient or a member of his family, and *have a record of having done so*, the attorney has withdrawn from the case, if such attorney was honest and ethical.

DR. W. L. ROSS (Omaha, Nebraska): I want to say a word about the prevention of reactions from the skin where we are using X-ray from day to day. Clinically, I have been using the X-ray for about fifteen years or more. At first it was quite common to get a redness and itching of the skin, and at that time a great many different remedies were suggested, such as the application of some sort of alkali.

Almost all of them have been discarded, but I have found two things to stand me in hand to prevent the itching that is first noted, and next the redness of the skin. I invariably tell my patients to apply salted butter over the area exposed and to leave it on for half an hour following each treatment and to continue it for a week after the treatments are discontinued. In addition to that, I apply a very

a warm solution, and thus accomplish what he desires.

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completely. The third-degree dermatitis has reduced in size about two-thirds, and we attribute that to the ultra-violet treatment. I would like to hear some explanation of that.

DR. A. U. DESJARDINS (Rochester, Minn.): May I make some explanations in partial answer to this question? MacKee and Andrews, Pfahler, and others have shown experimentally that ultra-violet radiation in addition to X-radiation simply adds to the effect. Therefore, if there has been marked erythema this will be increased by exposure to ultra-violet rays. This has been conclusively established, and there can be no doubt about it.

I think Sampson was responsible for the legend that exposure of an X-ray dermatitis to a strong dose of ultra-violet rays would cure the dermatitis. Such teaching is the rank-est heresy and wholly at variance with the facts. In cases of third-degree radiodermatitis, the ulcer may fail to heal and the patient may have severe pain for weeks, months, and sometimes for several years. In almost every instance the pain and the failure of epithelium to grow over are due to secondary infection. The important thing is to combat the secondary infection; as soon as this subsides, the pain also disappears. Some patients who have taken narcotics for months find this unnecessary. In some of these cases, after the secondary infection has been brought under control, short exposures to ultra-violet rays often hasten healing of the ulcer. When available, I prefer sunlight in small doses; large doses of ultra-violet rays should never be used.

As to the use of butter, I might say that it is well known in dermatology that any oily or greasy substance, any ointment, will give relief simply by removing contact of these irradiated surfaces from the air. So if butter or anything else will give relief under those conditions, it is perfectly all right.

But it has also been shown by MacKee and other dermatologists that greasy ointments in general have a tendency to increase the erythema rather than diminish it. So you have to be a little careful, and why butter should do the opposite, I do not know. I would, therefore, be a little skeptical about it.

DR. W. S. LAWRENCE (Memphis, Tenn.): I realize that the question asked by the gentleman who spoke of the burns on the three fingers of the first, second, and third degree has not been adequately answered, and I want to try to do that. He asks what did it if that did not do it. He gave the patient small doses of ultra-violet, the patient got well, and that was proof-positive. Remember that it is just one case that he cites, yet that was proof-positive that the ultra-violet did it.

I think it was "Dr." Abraham Lincoln who first said, "Time is a wonderful healer." Time is what did the work, time and keeping it clean. In my judgment you were deceiving yourself; and the gentleman who gave the infinitesimal doses of high frequency has likewise been deceiving himself. But I do not think that it is out of the question to do something in these cases—chiefly for the patient's mental benefit. One of the best things to do is to give oxide of zinc ointment to whiten the reddened area, or, better than that, paint the whole region with mercurochrome. That won't do a particle of harm and the patient then can't tell whether an erythema has developed or not.

DR. G. FAILLA (closing): So many different points have been brought up to-day and so much interest has been shown in this subject, that the discussion might be continued indefinitely. The lateness of the hour, however, makes it necessary to end the discussion. I shall take only a few minutes to answer a few of the questions which have been raised.

Dr. Newell inquired about the sensitivity of the fluorescent screen. I believe that under proper conditions, that is, in complete darkness and with the eye fully accommodated, the fluorescent screen can be used to detect very small intensities of X-rays. It should be noted, however, that there is an important distinction between the use of a fluorescent screen and a photographic plate or film for the detection of X-rays. The former reacts to a certain *intensity* of X-rays, whereas the latter records a certain *quantity* of radiation. This quantity may be attained by exposing the film to a very

soft high frequency current through a vacuum electrode. For the last four or five years I have rarely had any erythema. I invariably treat the patient right after the X-ray exposure with the soft high frequency current, which I generally use from five to ten minutes. It must be very soft. You can get much softer rays out of the vacuum electrode than you can get out of the non-vacuum electrode, and, understand all the time, that it is not an effect on the deeper tissues that you are trying to get out of the high frequency. It is just to protect the thin film of skin that has been over-stimulated.

DR. W. S. LAWRENCE (Memphis, Tenn.): I do not think the previous statement should go without question and without word of caution. It has been pretty well demonstrated that everything done for an actual or potential X-ray burn is very nearly in the nature of adding insult to injury. Some years ago a great many men advocated treating with ultra-violet to prevent an X-ray burn; and still it has been demonstrated experimentally over and over again that ultra-violet increases the X-ray effect and that hot applications make matters worse. Anything that over-stimulates or damages the skin in the least would make the X-ray effect more manifest, and not less. Likely if the gentleman has been getting apparent effects from what he speaks of as soft rays from a high frequency vacuum electrode (which in my understanding of the matter are not rays at all), he has been deceiving himself. The reason he got the apparent preventing effect was that he had not given enough X-ray in the beginning to produce anything like an erythema.

One other thing, referring to Dr. Trostler's remarks: There is a tremendous leeway between an X-ray erythema, mild or even pronounced, and an X-ray burn, or destructive erythema. I do not believe that suits are ever developed from simply a marked or pronounced erythema. The conditions that bring on suits are those in which the skin slips off and leaves an X-ray slough. The perfectly wise and sensible thing to do, which I think most of us have done, and will do, or are doing, is to tell the patient or the patient's family

of the possibility or probability of some skin reaction resembling sunburn—with which they are all familiar and of which they are not at all afraid.

DR. W. L. ROSS (Omaha, Neb.): May I correct a misapprehension of what I said? I spoke in favor of absolutely doing something before your erythema developed. I was not giving any treatment after erythema or mild or severe dermatitis had developed. That was not the object at all. It was to prevent any erythema from showing up, and it is a very mild form of treatment that I advocated. So do not misunderstand me. I did not advocate ultra-violet at all. It was high frequency.

DR. NEWELL: What do you consider your maximum safe dose, Doctor? From what doses are you rescuing the patients from dermatitis by using butter?

DR. ROSS: I advocate the use of butter simply because it contains salt and is soothing to the skin surface.

A far as the maximum dose of X-ray is concerned in producing or preventing erythema, it varies so with different individuals and different skins that, as you know, what will produce an erythema with one will not with another. Irrespective of the X-ray dosage, I make it a practice to use salted butter and high frequency in all cases of daily exposure to X-ray.

DR. J. S. YOUNG (St. Louis, Mo.): The first thing that I would like to ask is, if there is absolutely no effect or counter-effect of ultra-violet, why is it that we do get results in treatment of X-ray dermatitis from ultra-violet?

I have now three cases in which I am sure that we have gotten some very good results from the treatment, or apparently so, from ultra-violet. I am always open to conviction. If you can show me where we have no results, I would like to know your reasons for it. I will cite one particular case in which we had on one hand a second-degree dermatitis on the fourth finger, a third-degree dermatitis on the second finger, and probably a first-degree dermatitis on the first finger. The second- and first-degree dermatites have healed

completely. The third-degree dermatitis has reduced in size about two-thirds, and we attribute that to the ultra-violet treatment. I would like to hear some explanation of that.

DR. A. U. DESJARDINS (Rochester, Minn.): May I make some explanations in partial answer to this question? MacKee and Andrews, Pfahler, and others have shown experimentally that ultra-violet radiation in addition to X-radiation simply adds to the effect. Therefore, if there has been marked erythema this will be increased by exposure to ultra-violet rays. This has been conclusively established, and there can be no doubt about it.

I think Sampson was responsible for the legend that exposure of an X-ray dermatitis to a strong dose of ultra-violet rays would cure the dermatitis. Such teaching is the rank-est heresy and wholly at variance with the facts. In cases of third-degree radiodermatitis, the ulcer may fail to heal and the patient may have severe pain for weeks, months, and sometimes for several years. In almost every instance the pain and the failure of epithelium to grow over are due to secondary infection. The important thing is to combat the secondary infection; as soon as this subsides, the pain also disappears. Some patients who have taken narcotics for months find this unnecessary. In some of these cases, after the secondary infection has been brought under control, short exposures to ultra-violet rays often hasten healing of the ulcer. When available, I prefer sunlight in small doses; large doses of ultra-violet rays should never be used.

As to the use of butter, I might say that it is well known in dermatology that any oily or greasy substance, any ointment, will give relief simply by removing contact of these irradiated surfaces from the air. So if butter or anything else will give relief under those conditions, it is perfectly all right.

But it has also been shown by MacKee and other dermatologists that greasy ointments in general have a tendency to increase the erythema rather than diminish it. So you have to be a little careful, and why butter should do the opposite, I do not know. I would, therefore, be a little skeptical about it.

DR. W. S. LAWRENCE (Memphis, Tenn.): I realize that the question asked by the gentleman who spoke of the burns on the three fingers of the first, second, and third degree has not been adequately answered, and I want to try to do that. He asks what did it if that did not do it. He gave the patient small doses of ultra-violet, the patient got well, and that was proof-positive. Remember that it is just one case that he cites, yet that was proof-positive that the ultra-violet did it.

I think it was "Dr." Abraham Lincoln who first said, "Time is a wonderful healer." Time is what did the work, time and keeping it clean. In my judgment you were deceiving yourself; and the gentleman who gave the infinitesimal doses of high frequency has likewise been deceiving himself. But I do not think that it is out of the question to do something in these cases—chiefly for the patient's mental benefit. One of the best things to do is to give oxide of zinc ointment to whiten the reddened area, or, better than that, paint the whole region with mercurochrome. That won't do a particle of harm and the patient then can't tell whether an erythema has developed or not.

DR. G. FAILLA (closing): So many different points have been brought up to-day and so much interest has been shown in this subject, that the discussion might be continued indefinitely. The lateness of the hour, however, makes it necessary to end the discussion. I shall take only a few minutes to answer a few of the questions which have been raised.

Dr. Newell inquired about the sensitivity of the fluorescent screen. I believe that under proper conditions, that is, in complete darkness and with the eye fully accommodated, the fluorescent screen can be used to detect very small intensities of X-rays. It should be noted, however, that there is an important distinction between the use of a fluorescent screen and a photographic plate or film for the detection of X-rays. The former reacts to a certain *intensity* of X-rays, whereas the latter records a certain *quantity* of radiation. This quantity may be attained by exposing the film to a very

soft high frequency current through a vacuum electrode. For the last four or five years I have rarely had any erythema. I invariably treat the patient right after the X-ray exposure with the soft high frequency current, which I generally use from five to ten minutes. It must be very soft. You can get much softer rays out of the vacuum electrode than you can get out of the non-vacuum electrode, and, understand all the time, that it is not an effect on the deeper tissues that you are trying to get out of the high frequency. It is just to protect the thin film of skin that has been over-stimulated.

DR. W. S. LAWRENCE (Memphis, Tenn.): I do not think the previous statement should go without question and without word of caution. It has been pretty well demonstrated that everything done for an actual or potential X-ray burn is very nearly in the nature of adding insult to injury. Some years ago a great many men advocated treating with ultra-violet to prevent an X-ray burn; and still it has been demonstrated experimentally over and over again that ultra-violet increases the X-ray effect and that hot applications make matters worse. Anything that over-stimulates or damages the skin in the least would make the X-ray effect more manifest, and not less. Likely if the gentleman has been getting apparent effects from what he speaks of as soft rays from a high frequency vacuum electrode (which in my understanding of the matter are not rays at all), he has been deceiving himself. The reason he got the apparent preventing effect was that he had not given enough X-ray in the beginning to produce anything like an erythema.

One other thing, referring to Dr. Trostler's remarks: There is a tremendous leeway between an X-ray erythema, mild or even pronounced, and an X-ray burn, or destructive erythema. I do not believe that suits are ever developed from simply a marked or pronounced erythema. The conditions that bring on suits are those in which the skin slips off and leaves an X-ray slough. The perfectly wise and sensible thing to do, which I think most of us have done, and will do, or are doing, is to tell the patient or the patient's family

of the possibility or probability of some skin reaction resembling sunburn—with which they are all familiar and of which they are not at all afraid.

DR. W. L. ROSS (Omaha, Neb.): May I correct a misapprehension of what I said? I spoke in favor of absolutely doing something before your erythema developed. I was not giving any treatment after erythema or mild or severe dermatitis had developed. That was not the object at all. It was to prevent any erythema from showing up, and it is a very mild form of treatment that I advocated. So do not misunderstand me. I did not advocate ultra-violet at all. It was high frequency.

DR. NEWELL: What do you consider your maximum safe dose, Doctor? From what doses are you rescuing the patients from dermatitis by using butter?

DR. ROSS: I advocate the use of butter simply because it contains salt and is soothing to the skin surface.

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low intensity for a long time. Accordingly, in the ultimate analysis, the film is capable of detecting extremely small intensities of X-rays.

As to the possibility of an effect being produced on the red blood corpuscles before a depression of the white count is noticeable, I can only say that in the case of the many technicians we have examined at the Memorial Hospital, this has not been the case. The white count has always been affected first, but the red count is also influenced by prolonged exposure to radiation.

In regard to the relative merits of lead and concrete as absorbers of X-rays, I may point out that lead is a more efficient absorber even in the case of gamma rays. That is, a lead wall of the same *weight* as a concrete wall absorbs considerably more gamma radiation

than the latter. Furthermore, the lead wall, of course, is much thinner. It is perfectly feasible to use either material to attain the same degree of protection. Where space is not important concrete might be preferable. In our case we have used lead for the protective enclosure of the 900 K.V. machine for three reasons: (1) the space available was very limited; (2) more certain protection is afforded by lead because it cannot crack, and (3) the lead can be used again in case the machine is moved to other quarters.

In conclusion, I wish to take this opportunity to thank those who prepared papers for this symposium. The time and thought which they spent on this work, I am sure, will be appreciated by the members of this Society and all radiologists.

Research Shows Diet Not Responsible for Cancer.—Diet is not responsible for the development of cancer, it appears from experiments reported by Sir Leonard Hill in the *Lancet*. Sir Leonard described his studies of mice on different diets and different beddings, which he conducted in the National Institute for Medical Research.

"Cancers have occurred indifferently in mice on all diets and on all beddings," he reported. "The significant influence has been age."

While some of the diets had an effect on the size of the mice and their reproductive ability, there was no effect on the development of cancers.

Two-fifths of the cancers occurred spontaneously, the mice dying between the ages of

one and one-half and two years. About one-third of the cancers occurred in mice dying between two and two and one-half years. Three years in a mouse corresponds to very old age in a man, Sir Leonard Hill pointed out.

Besides reporting his investigations of mice, Sir Leonard Hill recounted observations on the relation of cancer and diet made by other investigators. In this connection he quoted a report of the Imperial Cancer Research Laboratory, as follows: "There is no reliable evidence, experimental, statistical, or clinical, which would indicate a causal correlation between cancer and the absence, or the presence, or the excess of any particular dietetic constituent. Sensational statements to the contrary are unfounded and ill-considered, and serve only to alarm the public."

HODGKIN'S DISEASE¹

By E. L. JENKINSON, M.D., CHICAGO

THE etiology, symptoms, prognosis, and pathology of Hodgkin's disease have been thoroughly covered by many writers, particularly Yates and Raine, Bunting, and others. I am chiefly concerned with the accompanying osseous changes and the treatment. I am quite sure that the incidence of bone involvement in Hodgkin's disease is much higher than the literature would lead us to believe. As we become more thorough in our examinations, insisting upon complete radiologic investigation of the skeleton, more and more will we find osseous involvement.

At the present writing, it is impossible to give statistics on the frequency with which bony changes occur. One cannot rely on the figures quoted in the older literature—the autopsies were not complete, and thorough X-ray examinations were not made.

It has occurred to us in the study of our cases that there is a similarity between bone metastases following carcinoma and bone changes in Hodgkin's disease. Review of the bones usually attacked by carcinomas and Hodgkin's disease shows them to be parallel. As is true in carcinoma, so in Hodgkin's disease also, the vertebrae, ribs, pelvis, and femora most frequently show changes.

These findings lead us to believe that the disease invades areas rich in red marrow. The cases we have examined revealed no changes in the bones distal to the elbows or knees. We know that there is an absence of red marrow in these bones after puberty. We are also aware that metastasis from carcinoma is relatively infrequent in these same bones. These observations have furnished material for speculation, so that we ask the

question, "Are the diseases similar in their methods of bone invasion?"

It is true, as far as we know, that Hodgkin's disease starts in the lymphatics, for a long period remaining confined to them. To admit these facts tends to discourage any further theorizing. However, we were not content to drop the subject and, on further investigation, found cases diagnosed as carcinoma of the lymph glands of the cervical region, proven by biopsy, with definite areas of metastasis in the ilium. It seems unlikely that the disease spread to the ilium by way of the lymphatics. It seems more reasonable and more probable that the extension was hematogenous. We are bearing in mind Handley's² work in which he presents the theory that cancer is disseminated by permeation of the lymphatics. Handley believed that metastasis occurred by extension of the tumor cells through the deep fascial lymphatics. It seems reasonable to assume that carcinoma of the breast might easily spread to the adjacent structures by way of the lymphatics, but the possibility of carcinoma of the breast metastasizing to the proximal third of the femur, by way of the lymphatics, does not seem reasonable or likely. The hematogenous route seems more accessible and plausible.

Von Recklinghausen³ holds that tumors spread through the blood stream into the bone marrow. The large number of distant bone metastases would lead one to believe there is sufficient proof to substantiate his belief.

To take a neutral position, one must admit that tumors may spread by both avenues.

¹HANDLEY, W. S.: *Cancer of the Breast and Its Operative Treatment*, John Murray, London, 1906, pp. 1-176.

²VON RECKLINGHAUSEN, F. D.: *Die fibrose oder deformierende Ostitis die Osteomalacie und die osteoplastische Carcinose in ihren gegenseitigen Beziehungen* Festschrift der Assistenten für Virchow, 1891, p. 17.

³Read before the Radiological Society of North America at the Seventeenth Annual Meeting, at St. Louis, Nov. 30-Dec. 4, 1911.

but, undoubtedly, most spread through the blood. Considering these facts as they apply to bone metastasis in carcinoma, we feel that metastasis to the bones in Hodgkin's disease is similar.

As in carcinoma, the bone changes are of two types, namely, osteoblastic and osteoclastic. The osteoblastic type shows considerable new bone formation, the bones being rather dense and homogeneous. The osteoclastic type, as in carcinoma, shows bone destruction and is by far more common than the osteoblastic.

Patients showing osteoblastic changes are usually in better physical condition, and, we believe, live longer. This is quite parallel with carcinoma metastases.

There is one other point which tends to make one think that the two diseases at least are similar in their methods of bone metastasis. Bone involvement is usually a rather late finding in both diseases, and the finding of osseous changes generally means that the patient is in the terminal period.

I have never observed bone changes in early Hodgkin's disease. I do not mean to infer they do not occur, as we, like others, have not carefully examined the skeleton in all of our cases. They may be found, after further study and more prompt radiologic examination, to be a common early finding, although, with our present information, we must consider bone changes as a late development in Hodgkin's disease.

On reviewing our films, we have been unable to find anything characteristic which might lead one to the diagnosis of Hodgkin's disease independent of the history, clinical findings, and sections. The disease causes both destructive and proliferative changes, but many other diseases do likewise. A differential diagnosis from the X-ray findings alone is impossible.

Another roentgenographic observation is the resistance which cartilage seems to offer to the progress of the disease. I have no

recollection of the disease ever having attacked a joint or passed through a joint. (This is also quite typical of metastatic carcinoma.) Infections have no respect for joints and cartilage. It is common to see them destroy a joint surface, passing through to the opposite articular surface.

TREATMENT OF HODGKIN'S DISEASE

For a number of years, we treated the entire lymphatic system of all patients suffering from Hodgkin's disease. This was considered as a prophylactic precaution. We were under the impression that, by treating the body from the hips to the head, the chance of the disease becoming generalized was minimized.

This practice was carried on for a long period, and we certainly did observe a marked improvement in the adenopathies. Disappearance of the enlarged glands is not unusual: glands far removed from the area irradiated usually become perceptibly smaller. Many explanations and theories have been offered for this phenomenon, such as secondary rays, and the possibility that the constituents of the blood may become radioactive. Some three years ago, we discontinued the practice of generalized irradiation in Hodgkin's disease and began treating only the enlarged glands. We then placed the patient on a liberal diet, accompanied by plenty of rest and sunshine. The belief was that improving the patient's resistance acted as a definite barrier to the progress of the disease.

When a patient presents himself for treatment and we find enlarged cervical and axillary glands, we irradiate these areas, using a dose up to the point of a mild erythema. We attempt to destroy the glands with one treatment. We then send the patient home, giving no more treatment unless other glands become enlarged.

This method was advocated by Dr. J. L.

Yates, for whom we have treated many patients. As we were familiar with Dr. Yates' work on diseases of the lymphatics and his work with Dr. Bunting, we were quite willing to try his method. Since our adoption of this procedure, our results have been better. Patients have lived longer and required less treatment.

One very important observation made since we have used our present method, is the absence of destruction of the blood-forming apparatus. With the older method, we have seen many patients in whom no glands could be palpated, but who were very weak and emaciated. The blood count usually showed a low hemoglobin content, with low red and an alarmingly low white count. When these patients are put on blood-building diets and transfusions, there is practically no response. The blood-forming apparatus has been destroyed, probably by the extensive irradiation.

We have experienced one serious mishap following irradiation of the entire trunk for Hodgkin's disease. We have never felt that the ill effects attributed by the pathologist to X-rays were due to the irradiation. In this case, the patient died as a result of a large perforated gastric ulcer. The pathologist, discussing the autopsy findings, very dogmatically stated that the cause of this large ulcer was the roentgen therapy.

The patient had not been treated for three months prior to his death. In December, he had received 300 r over the posterior and 300 r over the anterior abdomen, using 0.5 Cu plus 1 Al. The following February, he came into the hospital, complaining of pain in the abdomen which did not respond to medical treatment. The patient became progressively worse and surgery was advised. At operation, free pus was found in the peritoneal cavity. Drains were inserted and the abdomen closed. The following day the patient died. At autopsy a large ulcer, about 6 inches in diameter, with a perforated area about 0.5 inch in diameter,

was found on the posterior wall of the stomach.

If the ulcer was due to only moderate doses of irradiation, it seems peculiar that we rarely see these ulcers in the treatment of cancer in patients who receive large doses. The opinions of many radiologists and pathologists were solicited, and all were agreed that the ulcer was independent of the irradiation.

In October, 1928, a patient was referred to us for X-ray treatment who had been treated for three years for Hodgkin's disease, proven by biopsy. On examination the patient was found to be very weak; he walked with the aid of a cane, only with great difficulty. For the month preceding examination he had been confined to bed.

Physical examination revealed no palpable glands, but the left thigh was greatly swollen and there was much edema of the left ankle. X-ray films showed a destructive process, involving the proximal third of the left femur. There were areas of destruction interspersed with thick, dense trabeculae. The thigh was very painful, even when it was immobilized. The examination of the chest showed no evidence of bone involvement; the lungs and mediastinum were unusually clear.

The blood count was: red, 2,220,000; white 3,250; hemoglobin, 38; lymphocytes, 21; monocytes, 2; polymorphonuclears, 60; eosinophils, 15; band, 2. Anisocytosis—Type 4.

Previous to admission under our care, the patient had had frequent X-ray treatments to the glands of the neck and groins. When the bone lesion was discovered, he received irradiation over this area, using moderate voltage. For a short period during the treatment of the femur, there seemed to be definite evidence of regeneration of the bone. However, the pain recurred, and destruction displaced the repaired bone.

During this period of time, he received with apparent benefit, six blood transfu-

sions. In May he decided to change physicians and was given extensive X-ray therapy to enlarged abdominal glands, receiving much benefit and remaining quite well until August, 1929, when pain and weakness again developed. At this time the patient was very anemic and the blood count alarmingly low. Four blood transfusions were given. At the time of admittance to our care, the blood count was so low that we decided not to give further irradiation until the general condition was improved. He was put on iron-liver extract, and given blood transfusions from a robust man of about 35 years of age, using whole blood. Finally, after four transfusions and diet his count, Dec. 15, 1930, was: red, 3,580,000; white, 4,600; hemoglobin, 62 per cent.

Following consultation with Dr. Yates, it was decided to give deep X-ray therapy to the femur, using small doses frequently along with weekly blood transfusions.

Following roentgen therapy, the pain in the femur subsided and the patient remained quite comfortable during his stay in the hospital. The blood count, however, could not be kept up and each transfusion seemed to be of less value. His blood-forming apparatus seemed to be destroyed. On Dec. 20, 1930, we sent him to Florida, thinking the sunshine and warm weather might help his general condition.

His stay there was not beneficial, the pain becoming worse. The thigh became very large and hard. The ankle and flank became edematous. On Feb. 13, 1931, he returned to Chicago very weak, and it was evident he was nearing the end. His blood count was: red, 2,520,000; white, 2,650; hemoglobin, 46 per cent.

During his stay in the hospital, he developed diplopia and very severe headaches. Nodules were seen in the scalp and small destructive areas were found in the skull. The edema became very marked and diuretics, such as salyrgan, were given with no marked benefit. The edema and woody con-

sistency of the thigh, we believe, were due to the irradiation. The tissues were hard and leathery, and a mass could be palpated.

The patient's relatives desired to take him home, and, inasmuch as nothing more could be done at the hospital, we consented. On April 12, 1931, he died.

POSTMORTEM FINDINGS

The histologic picture of the tumor tissue in the sections of the mesentery was that of a Hodgkin's granuloma, with the typical confusion of many cell forms commonly seen in this disease.

The cell forms included large and small lymphocytes, plasma cells, eosinophile cells, endothelial cells, and endothelial giant cells. The endothelial cells, which were larger than lymphocytes, were pale, with elongated, rather pale, vesicular nuclei. The numerous giant cells varied considerably in size and contained from one to five or six large vesicular nuclei. These were rounded, indented, or multilobed, usually lying close together. In the nuclei of the giant cells there was one, sometimes two, rather deeply staining nucleolus. The cytoplasm was clear but scanty. The giant cells generally resembled the Dorothy Reed type. There were all gradations, from the mononuclear endothelial cell to the multinuclear endothelial giant cell. The endothelial cells, including the giant cells, formed the bulk of the tumor cells. The lymphocytes were not numerous. Some of the tumor cells were atypical; many of them contained hyperchromatic nuclei or bizarre mitotic figures. In this respect the tumor cells were more malignant in appearance than is usual in Hodgkin's granuloma; it is probable, therefore, that this was Hodgkin's sarcoma. The growth was not characteristic of lymphosarcoma. The reticulum was not very evident in some sections, whereas only hyalinized fibrous tissue, containing but a few small areas of tumor cells, was found in other sections.

In the femur, islands of bone were noted in areas composed of cellular tumor tissue. The bone marrow was entirely replaced by dense hyalinized connective tissue, containing only a few small areas of tumor cells. Sections of the mass about the femur in the thigh revealed tumor invasion of the connective tissue between the muscle bundles.

In sections of the liver, there were apparently a few tumor cells among the red blood corpuscles in the lumen of a larger blood vessel; otherwise no tumor tissue was evident here. There was slight atrophy, brown pigmentation, and fat-infiltration of the parenchymatous cells about the central veins (slight passive hyperemia). There were a few endothelial leukocytes laden with yellow-brown pigment in the sinusoids near the central veins. Only a few round cells were observed in the connective tissue of the portal spaces.

In the kidneys, there were small areas of tumor cells infiltrating the connective tissue stroma between the tubules. Although surrounded the glomeruli were not invaded. Hyaline casts and pink granular material were found in a few of the tubules; occasionally a tubule was dilated. The glomeruli were generally large, their epithelial cells somewhat vacuolated as if from lipoid degeneration. Some of the tubules and glomeruli did not stain, whether from necrosis or postmortem change it was difficult to say. An occasional glomerulus was hyalinized.

At first glance, the spleen seemed free from tumor tissue, but more careful examination disclosed the presence of a few scattered endothelial cells, containing from two to four vesicular nuclei such as those seen in the mesentery. The lymph follicles were small. There were numerous droplets of yellow-brown pigment, probably hemosiderin, in endothelial leukocytes and in the reticulum. The capsule and trabeculae were thickened with increased fibrous tissue.

Summary.—This was a case of malignant lymphoma (Hodgkin's type) in which ap-

parently complete disappearance of the original involvement in the neck occurred. At necropsy there was found: a mesenteric mass; infiltration in the kidney, and involvement of the bone marrow and periosteum of the femur. The latter is an uncommon, but not unknown, feature of this disease.

We feel that this patient was greatly benefited by X-ray therapy. He was more improved under doses directed to the involved glands than under generalized therapy. Following the generalized irradiation, the patient became very anemic, from which he did not recover. His blood-forming apparatus, which was destroyed, had no power of recuperation. I am aware that the disease might well cause the destruction, but, up to the time of the general irradiation, his blood remained quite normal. It is our opinion that isolated treatments directed to the involved glands does not tend to deplete the blood as much as extensive treatments.

A patient with bone involvement, whom we saw and treated in December, 1930, shows the benefit which can be obtained from well directed X-ray treatments.

The patient, a male, age 28 years, came to the hospital for X-ray therapy for Hodgkin's disease, so proven at the Mayo Clinic in December, 1928. At the time of admission to the hospital, Dec. 1, 1930, the patient was complaining of severe pain in his left leg, with edema of the ankle. He was well nourished but had lost 38 pounds since the onset of symptoms. During his stay in the hospital, he ran an afternoon temperature which was usually around 102°.

The urine showed nothing of importance. Blood count: red, 3,360,000; white, 11,000; hemoglobin, 61. Differential count, 300 cells. Lymphocytes, 33; monocytes, 7; polymorphonuclears, 23; eosinophils, 3; basophils, 2; band-shaped, 9; metamyelocytes, 2; myelocytes, 1. Type III. The blood chemistry was within normal limits; the blood calcium, 12.18.

The radiologic examination of the chest

showed the lung fields to be clear, except for an old empyema, seen in the right base. The mediastinum was clearly outlined, showing nothing of importance. The pelvis exhibited definite bone changes; the bones were very dense, probably due to the fact that the patient had taken cod liver oil and calcium.

There were definite changes in the left ischium, showing sclerosis and destruction. It was considerably widened, the sclerosis extending upward into the left acetabulum. Close examination revealed new bone formation laid down parallel to the ischium.

The patient was given X-ray treatments using 1 Cu + 1 Al, with 200 K.V.P., directed to the ischium. Posteriorly, 560 r in air were given, and 630 r anteriorly. The patient was sent home and placed on Bland's Pills, viosterol, and liver extract, which he took religiously.

His pain was relieved and the swelling of his ankle subsided. The patient gained and by April, 1931, he weighed more than he ever had before. His temperature also returned to normal.

The blood count on April 16, 1931, was: red, 4,610,000; white, 6,950; hemoglobin, 95 per cent. Polymorphonuclears, 62; small lymphocytes, 10; large lymphocytes, 24; transitionals, 3; eosinophils, 1.

Upon recurrence of the pain in the pelvis, since the blood count and general condition were very satisfactory, we decided to give another series to the lower pelvis, using the same factors. The result was prompt benefit to the patient.

The blood count was:

May 19, 1931.—Red, 4,860,000; white, 11,000; hemoglobin, 95 per cent. Polymorphonuclears, 89; small lymphocytes, 3; large lymphocytes, 5; eosinophils, 3.

July 13, 1931.—Red, 4,500,000; white, 6,900; hemoglobin, 98 per cent. Polymorphonuclears, 69; large lymphocytes, 17; small lymphocytes, 12; eosinophils, 2.

July 29, 1931.—Red, 5,030,000; white, 7,250; hemoglobin, 97 per cent. Polymorphonuclears, 67; small lymphocytes, 21; large lymphocytes, 8; transitionals, 4.

During the latter part of August, further X-ray examinations of the pelvis showed a marked improvement in the bony structure. The areas of absorption were much ameliorated, and the bones quite homogeneous.

Because the patient complained of pain on walking, on Sept. 9, 10, and 11, 1931, we gave him three treatments, two over the posterior pelvis and one over the anterior right pelvis, using 560 r posteriorly and 280 r anteriorly.

The blood count on October 6, 1931, was: red, 5,080,000; white, 5,900; hemoglobin, 98 per cent. Polymorphonuclears, 52; small lymphocytes, 33; large lymphocytes, 12; basophils, 2.

The last time we saw this patient he was feeling very well and the pain on walking was greatly reduced.

The important consideration in this case, other than the response to irradiation, was the improvement in the blood count despite rather heavy therapy. We feel that localized treatment certainly causes less destruction of the blood than generalized irradiation. The use of blood-building foods and drugs, such as iron, liver, peaches, prunes, and apricots, is of value in building up the blood. Viosterol, cod liver oil, and calcium chloride certainly stimulate bone production, even in diseased bones.

SUMMARY

1. Bone changes in Hodgkin's disease are not uncommon.

2. Our observations have led us to believe that the extension of Hodgkin's disease to the bones is similar to the extension from carcinoma.

3. The vertebrae, ribs, bones of the pelvis, and the proximal third of the femora are usually involved.

4. Bones rich in red bone marrow are attacked, whereas bones poor in red marrow are relatively free of involvement.

5. The X-ray findings are not sufficiently characteristic to make a diagnosis of the disease in the absence of clinical findings.

6. Cartilage, from our experience, is resistant to Hodgkin's disease.

7. We feel that localized, well directed irradiation is superior to generalized treatment.

DISCUSSION

DR. A. U. DESJARDINS (Rochester, Minn.): The whole group of lymphoblastomas contains so many different phases that, in the short time allowed, I could not begin to touch on many. The first point that interests me is the bone lesions. It is perfectly true that, in a certain small proportion of cases in the late stages of the disease, invasion of bone does occur, apparently as a part of the disease.

On the other hand, there is a still larger group in which lesions may result from pressure by enlarged lymph nodes. I have seen this in the sternum, from pressure of mediastinal nodes, in the ilium, from enlarged iliac nodes, and in the vertebrae, from enlarged retroperitoneal nodes. Therefore, both possibilities must be considered. Many seem to think that it takes a great deal of pressure to erode a bone. It does not. It is only necessary that the pressure be sufficient to interfere with the circulation of the periosteum; and, if such pressure lasts long enough, erosion, even of adult bone, will occur. In children, erosion develops even more rapidly.

Another question is that which relates to general irradiation and local irradiation. The choice, I think, must depend on the circumstances under which each radiologist works.

If the patients come from a limited radius, so that they can be seen and treated at frequent intervals without undue financial and physical stress, then local irradiation is perfectly proper and wise. If, on the other hand, one is working with patients coming from Kansas, from Texas, from California, from New York State, from the upper peninsula of

Michigan, etc., the problem is quite different. Many patients are poor and cannot come back frequently. If adequate facilities for treatment are not available for hundreds of miles, it is essential to give patients a form of treatment which will keep them in the best possible condition for as long a period of time as is possible.

Until 1924, we followed the scheme of local irradiation. We treated only those regions in which there was definite and visible involvement, but we often found that patients had hardly had time to return home before lymphadenopathy would appear in some other region.

The result was that, in 1924, we began to modify our scheme of treatment by irradiating, at one time, the areas obviously involved and also the mediastinal and retro-abdominal nodes, at first, usually through the back only. We gave one, two, and sometimes three, such courses of treatment at intervals of three or four weeks. Subsequently, treatment was limited to the regions in which fresh adenopathy developed. Thus, we have been able to keep patients in better condition for a longer time than we had been able to before.

In my experience, fever in lymphoblastoma generally means abdominal involvement. My reason for this deduction is that, when a patient has fever, judicious irradiation of the abdomen is usually followed by diminution, or disappearance, of fever as the lymphadenopathy recedes. This occurs so frequently that, when a patient with fever is referred to us, we almost take for granted retroperitoneal or omental lymphadenopathy, and we are seldom proved wrong.

DR. AARON ARKIN (Chicago, Ill.): In the last two and one-half years, on our service at the County Hospital, we have adopted the plan of making X-ray studies of the bones in most cases of Hodgkin's disease, especially if there is pain or swelling. In this period, I have seen eight cases with extensive bone involvement.

One was very interesting. A young man, 24 years old, was admitted to the hospital with a large lumbar mass and paralysis of both lower extremities. Examination revealed a charac-

teristic relapsing fever with periods of a temperature of from 100° to 102° for from five to ten days, followed by several days of normal temperature. There was generalized lymph gland enlargement. Biopsy of one of the lymph nodes showed a very active form of lymphogranuloma. A good orthopedic surgeon made the diagnosis of Pott's disease, but my explanation was lymphogranulomatosis of the lumbar spine with an external pachymeningitis. The X-ray studies revealed extensive osteoclastic and osteoplastic changes in the first and second lumbar vertebrae, the destruction involving the transverse processes of the second lumbar vertebra, which is rarely seen in tuberculosis. A laminectomy was done, revealing lymphogranuloma of the vertebra with a large lymphogranulomatous mass compressing the dura against the spinal cord. This agreed with our diagnosis, as we had seen the same condition, postmortem, in three other cases. The laminectomy relieved the pressure symptoms and the boy regained the use of his lower extremities. However, he died a few months later of generalized Hodgkin's disease.

I have also seen a case with extensive involvement of the pelvic bones. Another case of the abdominal type, with tremendous enlargement of the liver and spleen, later developed intercostal pain. Films of the dorsal spine revealed extensive destruction of the ninth dorsal vertebra. X-ray treatment caused the liver to return to normal size, in spite of the fact that there was complicating perihepatitis with a friction rub.

In a woman, 35 years old, with slight general adenopathy, we found extensive destruction of the right clavicle, which, histologically, revealed Hodgkin's disease. Another patient presented extensive destruction of the right humerus, with marked induration of the surrounding soft tissues and swelling. I have also seen lesions in the ribs, and in the radius. In fact, any part of the osseous system may be affected.

I do not think that we are justified, from our pathologic studies or clinical observations, in calling this disease lymphoblastoma. This term confuses even more the present status of this disease. A blastoma is a neoplasm, and

we are not justified in considering Hodgkin's disease as such.

At present the evidence is in favor of the infectious theory. As in tuberculosis, syphilis, and actinomycosis, so in lymphogranuloma, any tissue or organ may be involved by hematogenous or lymphatic spread. The extensive involvement does not justify the use of the term blastoma. The relapsing fever, the course of the disease, and the microscopic findings speak rather for an infectious granuloma. I have seen Hodgkin's disease with extensive lung involvement which suggested a primary pulmonary infection similar to tuberculosis. The lung areas may be very large and simulate several other diseases.

I should like to suggest an addition to Dr. Jenkinson's two types of bone change, as follows:

1. Osteoclastic
2. Osteoplastic
3. Combined
4. Indifferent

Unless microscopic examinations are made of the various bony structures, the last of these types is overlooked. In this type, the bone marrow is replaced by lymphogranuloma without sufficient bone change to produce X-ray findings. Only the pathologist who makes microscopic sections can exclude the presence of metastases in the bones or other tissues. The spleen and liver are involved in a very high percentage of cases seen postmortem.

DR. DESJARDINS: I agree with Dr. Arkin that the preponderance of evidence at the present time tends to support the idea that at least Hodgkin's disease, and probably most of these lymphoid disturbances, have a chronic infectious basis. I do not mean that they are infectious in character, but that the etiologic background is probably one of chronic infection.

Nevertheless, by the time we see the patients, there is no question but that we are dealing with a malignant disease. It kills nearly all of them, metastasizing to various organs. If that is not malignant, I do not know what is.

In the case referred to by Dr. Arkin, the friction rub and various other points indicate

actual liver enlargement. True enlargement of the liver unquestionably occurs, but in many cases the impression of enlargement appears to be due to the organ being pushed forward and downward by enlarged retroperitoneal nodes. When the lymphoid hyperplasia is made to recede by irradiation, the liver as promptly resumes its normal position and size. I have seen this so many times that I cannot draw any other conclusion.

DR. ARKIN: Liver metastases are demonstrated by the pathologist in a very high percentage of cases. Some of the largest livers I have seen have been in Hodgkin's disease, these showing extensive areas of necrosis, yellow in color.

The liver is very frequently involved in Hodgkin's disease.

DR. DESJARDINS: In what percentage does your pathologist show involvement of the liver? Our records show it in less than 20 per cent of the cases.

DR. ARKIN: I should say in the spleen about 40 and in the liver about 20 per cent.

DR. DESJARDINS: That is not so very high.

DR. JENKINSON (closing): I do not doubt what Dr. Desjardins has said about fever, but a great many of these cases present fever very early. It is one of the earliest symptoms we find. At the present time, we have under observation a man whom we have been treating for, I think, about seven years. All he has ever had, as far as we can determine, are a few pathologic cervical and axillary glands, but fever has been one of his main symptoms. He comes back occasionally and we treat the involved glands.

I think, as Dr. Desjardins says, that generalized irradiation depends upon the patient, and, after all, he is the first one to be considered. We did, for a long time, give generalized irradiation and a number of our cases improved—at least their adenopathies subsided, becoming smaller. There are men treating Hodgkin's disease who have the patients return again and again, for the duration of their lives, which is absolutely wrong. These radiologists are not going to help their patients; they are going to kill them. That is why I think that practice is bad.

MEDICAL EXPERT WITNESS RECEIVING A PERCENTAGE OF AMOUNT OF JUDGMENT FOR HIS FEE

By I. S. TROSTLER, M.D., F.A.C.R., F.A.C.P., CHICAGO

ASIDE from and in addition to the reasons that it is against public policy and extremely bad ethical practice on the part of all who are in any way connected with such a transaction, the principle of a witness arranging that the amount of his fee be dependent upon the amount or value of the verdict tends to induce perjury in favor of the contestants of the case using such witness. As such, it must be condemned and disapproved.

There are several leading Supreme Court decisions to the effect and meaning that a contract to pay a witness for testifying, coupled with the condition that the amount of his compensation depends on the outcome or result of the suit in which his testimony is used, is contrary to public policy and void, because it tends to perjury and the perversion of justice. Among these may be cited: *Clifford vs. Hughes*, 139 App. Div. 730, 124 N. Y. Supp. 478.

State vs. First Bank of Nickerson, 184 Neb. 423, 207 N. W. R. 674, etc.

Miller vs. Anderson, 183 Wis. 163, 196 N. W. R., 869, 34 A. L. R. 1529.

County of Campbell vs. Howard, 113 Va. 19, 112 S. E. R. 876.

In the following case (*Davis vs. Smoot* (N. C.), 97 S. E. R. 488), a physician witness who arranged for and made it a point to immediately collect 20 per cent of the amount of the verdict, was compelled to repay the \$125 so collected and was rightfully threatened with contempt of court proceedings. This should be a good object lesson to any witness who may be contemplating making or being tempted to make such an arrangement or contract.

The Supreme Court of North Carolina, in 1919, affirmed a judgment in favor of the plaintiff, administrator of the estate of

one A. M. Davis, against the defendant, a physician, for \$125, the amount which the defendant had collected from A. M. Davis for testifying as a witness in a personal injury case against the city, in which Davis recovered \$625.

The Court said: "These issues were submitted to the jury in this action against the physician: (1) Did the defendant knowingly, designedly, wilfully, and maliciously and unlawfully charge A. M. Davis 20 per cent of the amount recovered by A. M. Davis from the city as alleged in the complaint? *Answer*: Yes. (2) What amount, if anything, is the defendant indebted to the plaintiff? *Answer*: \$125."

"The defense was rested on the ground that the agreement was void as against public policy, and hence that the money having been paid, the plaintiff administrator could not recover it back. It is public policy that such a transaction as this cannot be allowed to stand simply because the defendant was able to enforce payment of the illegal exaction.

"Besides, there was in this case evidence that the defendant physician gave said A. M. Davis morphine and other medicines, that the latter's mind while the defendant was visiting him and giving him morphine was in a very unsatisfactory condition, and that the defendant, who 'had made a very good witness,' collected the \$125 with great promptness after A. M. Davis had received it.

"The ground of the recovery sought by the plaintiff administrator was, not that the defendant swore falsely in favor of A. M. Davis, but that he made representations that his testimony would be more effective if he were paid 20 per cent of the amount that

A. M. Davis recovered, and that after the trial he collected said 20 per cent out of the client over and above his expert witness fee of \$10 allowed by the court.

"This court will not only not enforce a contract of this kind, but will compel repayment when collection has been made and there is evidence that the party making payment was under treatment and also under the influence of morphine administered by the defendant until after the money was paid him, and that thereafter when his physician was changed the patient's mind improved, and he made an effort to secure the return of the money.

"On the verdict on the first issue, that the money had been 'designedly, wilfully, maliciously and unlawfully collected by the defendant,' the court very promptly gave judgment for its return. No court with a proper sense of its own dignity and of purity in the administration of justice, which should always be above suspicion, could permit such a transaction to stand, simply because the offender has been quick enough to secure payment before proper action could be taken.

"The defendant on the verdict was guilty of gross contempt of court. It is commended to the consideration of the court below, whether, on the evidence in this case, proceedings in contempt should not be brought by the court in vindication of public justice, and it is for the solicitor to consider whether a bill should not be laid before the grand jury for indictment of perjury in view of the intimation by the defense in this trial that A. M. Davis was unduly benefited by the too favorable testimony of the defendant in the trial of the action against the city. The transaction is not one that the court can in justice allow to go off without investigation.

"The answer did not deny the receipt of the 20 per cent by the defendant, but alleged that it was a voluntary gift. But the defendant did not go on the stand nor put on

any evidence to support such defense. This certainly calls for investigation by the court. Such conduct by a witness as was here described and indicated by the verdict, strikes at the very heart and root of the administration of justice. The courts cannot be too careful and scrupulous in this particular."

CASES CITED¹

WORKMEN'S COMPENSATION COMMISSIONER HAS POWER TO PUNISH FOR CONTEMPT

In re Hayes (N. C.), 156 S.E.R. 791

On March 3, 1930, Dr. R. B. Hayes was present as a witness before the chairman of the North Carolina Industrial Commission. He had professionally attended the claimant, who was seeking compensation. Dr. Hayes had been sworn and had testified on both direct and cross-examination. The chairman of the Commission then asked Dr. Hayes whether he had an opinion as to whether or not a blow received by the claimant on October 19 would have produced a paralytic stroke on January 12. Dr. Hayes admitted that he had an opinion, but he refused to express it unless he received compensation as an expert. Section 3893 of the Consolidated Statutes provides that experts, when compelled to attend and testify as witnesses, shall be allowed such compensation and mileage as the court in its discretion may allow. The chairman of the Commission, however, maintained that it was not up to him to qualify Dr. Hayes as an expert and committed him to jail for contempt of what the chairman described as "the Court." Dr. Hayes sought to obtain his release through a writ of *habeas corpus*, but failed. Thereupon he obtained a writ of *certiorari* for a review of the case by the Supreme Court of North Carolina.

Power is expressly conferred by the statute creating the North Carolina Industrial

¹Reprinted by permission from the *Journal of the American Medical Association*.

Commission, said the Supreme Court, for that Commission or any member of it to subpoena witnesses to attend and testify at a hearing before the full Commission or before any member, and the statute provides that "the Superior Court shall, on application of the Commission or any member or deputy thereof, enforce by proper proceedings the attendance and testimony of witnesses and the production and examination of books, papers, and records." This provision that the Legislature had made for enforcement by the Superior Court of the attendance and testimony of witnesses and the production and examination of books, papers, and records, however, the Supreme Court thought was not adequate for a situation such as that presented in the present case. If a witness in attendance at a hearing, after having been duly sworn, can with impunity refuse to answer a question propounded to him which is pertinent to the matters in dispute between the parties, then, the Supreme Court thought, the Industrial Commission would be without adequate power to perform its duties. Since the Legislature in providing the Commission with the aid of the Superior Court in enforcing the attendance and testimony of witnesses did not in express terms—nor, in the opinion of the Supreme Court, by implication—deny to the Commission or any member thereof the power to compel a witness in attendance at a hearing, after having been duly sworn, to testify, the court, without deciding whether the North Carolina Industrial Commission was or was not a court, and without citing any statutory authority or judicial precedent in support of its opinion, concluded that the Commission or any of its members has the power to adjudge a witness in contempt who has deliberately and persistently refused to answer a question propounded to him and to punish such witness by fine or imprisonment. The judgment of the Industrial Commissioner was therefore affirmed.

The question raised by Dr. Hayes at the hearing before the chairman of the Industrial Commission, said the Supreme Court, when he refused to answer the question addressed to him because it was addressed to him as an expert and he had not been paid as an expert nor assured that he would be so paid, was not presented to the Supreme Court for decision and had not been decided by that court. It has been held in a few courts that a witness who has been summoned as an expert in a judicial investigation cannot be adjudged in contempt for refusing to give such testimony unless he has been compensated for his professional opinion. The better opinion, however, said the Supreme Court of North Carolina, is that an expert summoned to testify, who refuses to answer questions "without compensation other than his witness fees," is in contempt, and when an expert voluntarily submits himself to an examination as such, he can in no case refuse to answer one particular question after having without objection answered others.

ADMISSIBILITY OF PHYSICIAN'S OFFICE RECORDS

Ohme vs. Bisimanis (Ala.), 132 So.R. 161

The appellee, Dennis Bisimanis, based his suit on double hernias, which he claimed were caused by his having been negligently struck by the defendants, with an automobile, Oct. 30, 1929. The case was tried, Jan. 30, 1930, and judgment given in favor of Bisimanis. Thereafter the defendants learned that some time before the date of the alleged accident a physician had found that Bisimanis was then suffering from double hernias. They then moved for a new trial, on the ground of newly discovered evidence. In connection with that motion, it was stipulated between counsel for Bisimanis and counsel for the defendants that a certain physician, if he were present

and testifying on the motion, would testify that the records in his office showed that he examined one Dennis Bisimanis in his office, March 25, 1929, and found that he was suffering from double hernia, and that he advised an operation, but that the physician had no recollection of the matter independent of his office records. A rehearing was denied, and the defendants appealed to the Supreme Court of Alabama. On behalf of Bisimanis it was argued that neither the hospital [*sic*] records nor their contents were evidence of the facts. But, said the Supreme Court, these records, under the well settled rules of the court, were admissible on proof that the witness knew the facts when the records were made, knows that the records show the true facts, and now has no independent recollection. The cause was remanded for a new trial.

CATCHING OF NERVE IN FRACTURE: EVIDENCE: FAILING TO USE ROENTGEN RAY

Ingwersen *vs.* Carr & Brannon *et al.* (Ia.),
164 N.W.R. 217

The Supreme Court of Iowa, in reversing a judgment obtained by the plaintiff and remanding this cause for a new trial, says that the petition alleged that the plaintiff sustained a fracture of his left arm, the humerus being broken at the juncture of the upper and middle thirds, and the broken ends of the bone being so separated and not in apposition that the musculospiral nerve was drawn in between the pieces of bone. There was evidence that, to show the plaintiff's daughter where the break was, the defendant then in attendance, who had given the plaintiff an anesthetic, raised the arm on a level with the shoulder, then straightened out the arm, and applied splints and a bandage. The plaintiff's theory was that the oblique fracture of the humerus involved the musculospiral groove, containing the nerve, and that when the defendant manipulated

the arm, and bent it at the point where it was broken, the nerve slipped in and was caught when the two pieces of bone closed up, and that it was negligence to fail to find out that the nerve was caught before the splints and bandage were applied, which should have been done by the getting of crepitus. For the defendants there was evidence which tended to show that crepitus was obtained, the fracture reduced, temporary splints applied, the forearm and hand placed in a sling, and the arm encased in a muslin swathe extending around the body. The defendants contended that the plaintiff had two injuries—the fractured humerus and an injury to the nerves; that they treated the fractured humerus and treated the nerve expectantly; that is, waited to give Nature a chance to clear up the paralysis without surgical interference, relying on Nature to clear up the injury to the nerve. The discovery of the musculospiral nerve between the broken ends of the bone was made by another surgeon, who cut down on the fracture something like eight weeks after that was sustained, and the defendants contended that the fact that the nerve was between the broken fragments of the bone then did not tend to prove that it was there two months before, when the arm was first dressed by the defendants; that presumptions do not relate backward. But the Court thinks there were circumstances which tended to show, and from which the jury could have found, that the nerve was caught prior to or at the time of the defendant's first visit. There was a conflict in the testimony which made this a jury question.

The jury was instructed that it was not to take for granted that the statements contained in the hypothetic questions were true, but that it should scrutinize the evidence and determine what, if any, averments were true, and that if it should find that some of the material statements were not correct and were of such a character as entirely to

destroy the reliability of opinions based on the hypothesis stated, it might attach no weight whatever to the opinions based thereon; that an opinion based on a hypothesis wholly incorrectly assumed, or incorrect in its material facts, and to such an extent as to impair the value of the opinion, is of little or no value. It was contended that the jury should not be permitted to determine the materiality of assumed facts incorporated in hypothetic questions; that the materiality of such facts is a question to be determined by the Court, and the Supreme Court holds that it was for the error in this instruction that the case must be reversed.

It was also error not to permit the defendant who performed the most of the services in the treatment of the plaintiff to be asked as to whether the best of his professional ability was brought to bear on the case; whether or not he exercised his best skill and knowledge in the treatment of the case, and what was the fact about his having exercised the utmost good faith as well as his best skill and ability in the treatment of this case. These questions were not leading or suggestive, nor did they call for the conclusion of the witness.

There was no error in admitting evidence as to there being roentgen-ray machines in the town in which the defendants were practising that were available to them. That they did not use a roentgen-ray machine was a circumstance to be considered by the jury as bearing on the question as to whether they failed to use ordinary care to discover that the nerve was caught.

REMOVING SUPERFLUOUS HAIR WITH ELECTRIC NEEDLE IS PRACTISING MEDICINE

Engel vs. Gerstenfeld (N. Y.) 168 N. Y. Supp. 434

The Supreme Court of New York, Appellate Term, Second Department, reverses a judgment obtained by the plaintiff for a bal-

ance claimed to be due for the removal with the electric needle of superfluous hair from the face of the defendant's niece, a Miss Abrams, because the plaintiff, not being a licensed and registered physician, in undertaking to treat Miss Abrams for the growth of hair on her face, violated the provision of the public health law regulating the practice of medicine. Justice Benedict holds that, as the plaintiff committed a misdemeanor in undertaking to treat the "deformity" or "physical condition" of the skin of Miss Abrams, the plaintiff was not entitled to recover in this action. Justice Clark concurs in the result, on the ground that the plaintiff practised medicine, in that, following the definition of the statute, she held herself out as being able to diagnose, treat, and operate for a certain physical condition, and undertook to diagnose, treat, and operate for such physical condition. Justice Callaghan dissents.

Justice Benedict says the "practice of medicine" is defined in the statute as follows:

"A person practises medicine within the meaning of this article, except as hereinafter stated, who holds himself out as being able to diagnose, treat, operate, or prescribe for any human disease, pain, injury, deformity, or physical condition, and who shall either offer or undertake, by any means or method, to diagnose, treat, operate, or prescribe for any human disease, pain, injury, deformity, or physical condition."

The growth of hair on Miss Abrams' face when she went to the plaintiff was a "deformity" or a "physical condition," of which she, or the defendant, desired the aid of the plaintiff in the treatment and cure; and the plaintiff clearly held herself out to them as being able to treat it successfully, and did undertake to treat it with an instrument known as an electric needle. The statute plainly means that a person holds himself out as being able and willing to diagnose or treat any human disease or "de-

fornity" or "physical condition" when he represents or states to a patient that he possesses the skill or ability requisite for the case. It is not essential that the "holding out" should be by way of public announcement. If there be a "holding out" of oneself as willing to undertake the treatment and able to administer it, then it follows that this constitutes the practice of medicine within the terms of the statute. Nor can it be said that the removal of hair from the face of a woman by the use of an electric needle does not properly come within the category of the practice of medicine any more than the removal of hair from the face of a man by the use of a razor would. Bouvier's Law Dictionary, speaking of surgery, says, "The practice of surgery is limited to manual operations usually performed by surgical instruments or appliances." The use of an electric needle would obviously come within this definition.

The definition of the term "practice of medicine" contained in the statute may be thought by some persons to be highly artificial. It includes, and was designed to include, many things not popularly considered as medical practice. But the wisdom of the law, if it be constitutional, is a matter for the consideration of the Legislature and not of the courts. It may well be argued that four years of medical study, including a thorough knowledge of anatomy, materia medica, hygiene, etc., in all their branches, are not requisite to equip a person properly to remove superfluous hair alone. Yet it can hardly be contended that persons engaging in that occupation should not be subject to some sort of regulation to insure proper skill and sanitation, such at least as the regulations affecting the practice of chiropody. The Legislature has seen fit to set a much higher standard, and until the statute herein discussed is amended or abrogated, the courts have no discretion but to enforce it.

CASE REPORTS AND NEW DEVICES

A PROPOSED DIAPHRAGM FOR STANDARD IONIZATION CHAMBERS¹

By HERMAN E. SEEMANN, Ph.D.

From the Kodak Research Laboratories,
ROCHESTER, N. Y.

It is a well-known fact that the results of measurements made with a standard ionization chamber cannot be known with a greater degree of accuracy than the cross-sectional area of the limiting diaphragm. If a diaphragm were constructed with straight sides instead of the conventional round hole, the straight sides could probably be more easily and accurately fine-ground than the

round hole. The following design for a diaphragm is proposed with the idea that probably somewhat greater accuracy may be obtained by its use and simple construction be retained. The diaphragm described is only *apparently* more complicated than a circular hole cut in a solid plate.

Two lead-bismuth alloy² plates *A* and *A'* (Fig. 1) are fastened together at their ends with simple metal yokes. Their edges *E* and *E'* are accurately machined for straightness and are as nearly parallel as possible. If a second pair of plates is similarly arranged and laid over the first pair at right-angles to it, the device in Figure 1 (*B*) re-

¹We are indebted to Mr. M. V. Bacon, of our laboratory shop, for certain practical suggestions regarding construction.

²Taylor advises against the use of "hard" lead in favor of "hard" gold or lead-calcium alloy. *RADIOLOGY*, January, 1932, XVIII, 113.

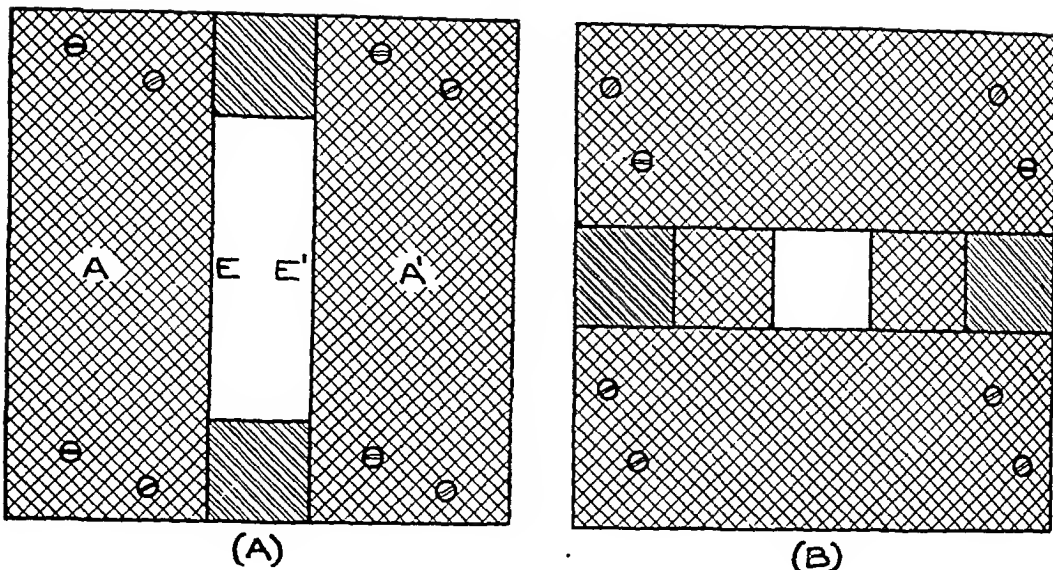


Fig. 1.

sults. The two pairs of plates thus mounted together comprise an easily constructed diaphragm.

The size of the opening is most accurately determined by measuring the distance between the plates of each pair at equal intervals along their entire length. Perhaps a slight taper (lack of parallelism) of the edges will be detected, but with reasonably good machine work on the edges the *uniformity of the taper* should be very good. The mean of these measurements is then the effective width of the diaphragm. It is to be noted that, when measurements are made near the ends of the plates, a more accurate determination of the effective width of the diaphragm is obtained than with measurements on the diaphragm only, assuming accurately straight edges. Great accuracy

in crossing the plates at right-angles is not essential since, for example, the area of the parallelogram formed by the crossing of such plates at 89 degrees is only about 0.015 per cent greater than if crossed at 90 degrees.

Owing to the necessity for thick plates to absorb the X-rays, a correction must be made for the fact that the two pairs of plates are at different distances from the source. No more data than are normally taken or known in standardization work are necessary to make this correction. Referring to the schematic diagram (Fig. 2), we see that slit "A" is defining the beam in the vertical direction at distance X_1 , and "B" is defining it in the horizontal direction at X_2 . It is assumed that the distance X_1 is the most convenient to measure directly.

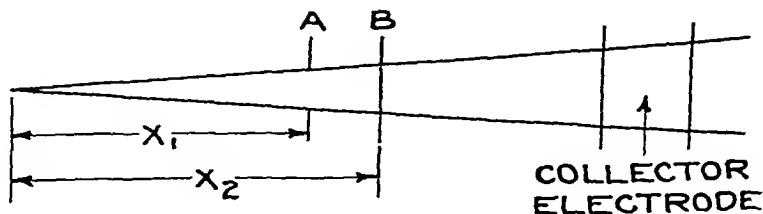


Fig. 2.

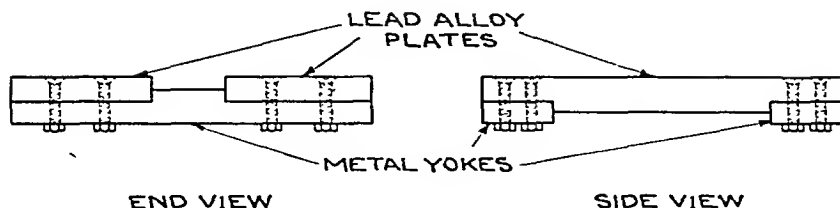


Fig. 3.

The effective width of "B," that is, the width it would need to have at X_1 in order to limit the beam to the same extent, is $\frac{X_1}{X_2}b$, where "b" is the measured width of "B." Thus, the effective area of the diaphragm at distance X_1 is $\frac{X_1}{X_2}ab$.

If desired, this type of diaphragm could be made adjustable by equipping the pairs of plates with micrometer screws.

The utility of the crossed slit diaphragm does not depend upon the shape of the edge chosen.

Figure 3 illustrates a method of insuring rigidity.

AN UNUSUAL FOREIGN BODY IN THE STOMACH¹

By ARTHUR LEDERER, M.D., Pathologist and
Roentgenologist, Veterans' Administration Hospital,
JEFFERSON BARRACKS, MISSOURI

In studying the X-ray films of the abdominal area of a 93-year-old Civil War veteran, who was a patient in Veterans' Administration Hospital, Jefferson Barracks, Mo., an unusual foreign body was observed on the left side of the lumbar spine and somewhat above the iliac crest. The author does not recall having seen any such a foreign body on any other X-ray film, nor did a cursory search of the literature furnish any precedent. Inquiry among some widely experienced civilian roentgenologists added no information.

Figure 1 furnishes a better conception of this foreign body than can be obtained by

mere description. The first point to be settled was whether or not this shadow originated from extraneous sources and, if not, if the shadow was fixed in the position first seen. A large number of films, made at intervals extending over several weeks, proved that the body was definitely fixed, but that it moved upward with the patient in the prone position. Having established this fact, it now remained to identify the exact location of the foreign body, its nature, and its relation to the clinical history. Since the foreign body has the shape of a

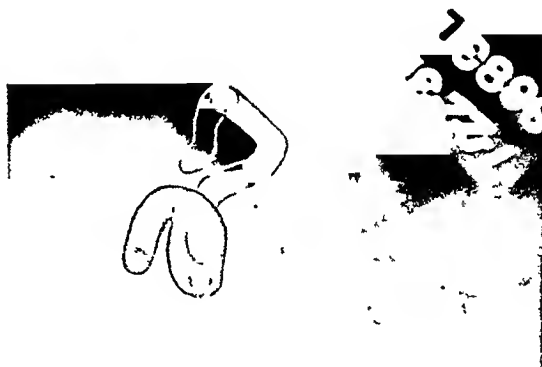


Fig. 1. (Retouched film.)

coil, it shall be so referred to in this discussion.

The first impression one receives in viewing the film is of a large calcified nematode, but the circular ends of the tape-like body, and its width, suggest that it is a tube, flexible and radiopaque. The odd shape weighs against its being a calcified blood vessel.

The patient was admitted to the hospital July 21, 1931. He comes from a family in

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which the father reached the age of 110 years and the mother lived to be 100 years old. The patient, who is of medium height and stocky build, has had no diseases of childhood. During his service in the Civil War, he was wounded in the right leg, but there was no injury to the chest or abdomen. No laparotomy scars were visible, and there were no markings of any sort on the skin. He had also served in the Spanish-American War but did not remember the exact dates of service. His hearing was greatly impaired and his memory somewhat faulty. He did not, however, present evidence of senile mental deterioration to a point at which one would have had to doubt the veracity of his statements. The patient came to the hospital suffering from shortness of breath and some cardiac pain; he could not rest while lying down and occasionally had difficulty in urination. Sometimes the wound in his leg caused him trouble, and he used crutches at the hospital.

The physical examination of his abdomen revealed very mild diffuse tenderness and an enlarged superficial vein in the suprapubic region. The principal pathologic conditions found were: Chronic myocarditis, degenerative; chronic bronchitis, associated with emphysema; moderate hypertension; general arteriosclerosis; chronic nephritis without edema, and a right inguinal adenitis.

The X-ray films showed the presence of a proliferative osteo-arthritis of the lower thoracic spine, apparently inactive.

The patient was discharged September 3, 1931, as not being in need of further hospitalization. From the foregoing description it may be noted that the coil could hardly bear any relationship to the patient's present pathologic condition.

Once it was established that the coil was fixed, it remained to be determined whether or not it was located within the gastric ventricle. In order to be able to take comparative measurements on the film, all of the ex-

posure factors had to be identical. The film target distance was 27 inches. In the upright position the lower level of the coil was 6.6 cm. above the iliac crest, it being lodged on the left side near the vertebral column midway between the first and second lumbar vertebrae. In the prone position, it moved up to coincide with the area occupied by the first lumbar vertebra, but, in the vertical plane, the distance between it and the lumbar vertebrae remained stationary. Occasionally, in the prone position, the coil moved upward to a level between the first lumbar and twelfth thoracic vertebrae. Previously, it had been determined with the aid of a barium enema that the coil was not within the colon. In the lateral exposure it was 2.5 inches anterior to the vertebral column.

Inasmuch as it was almost certain that the coil must be within the gastric ventricle, a barium meal was given on several occasions. The patient was of the hypersthenic type, and the stomach of the horizontal variety. In standing posture, the lower pole of the stomach was 2.5 cm. above the iliac crest, moving up to a point 10.5 cm. above the iliac crest in the prone position. The pars media and the pylorus appeared narrow, but there was no defect in their contour. The pylorus opened at once, revealing a normal bulb and antrum. The patient complained of pain on pressure over the ensiform process, which point was above the pylorus. The coil was obscured by the barium in the standing, lateral, and prone positions. At the end of five hours the stomach was empty with the exception of a small amount of barium which was attached to the coil on the left side. The duodenum, including its second and third portions, did not exhibit the usual bend downward and to the left, but appeared to extend in an almost horizontal direction to the right. The fact that the coil moved upward sometimes to the level of the twelfth thoracic vertebra in the

prone position suggests that its movement depended on the position of the gastric ventricle at different intervals. Naturally the extent of the upward movement depended on the amount of gastric content present at the time of exposure. Inasmuch as the stomach was of the horizontal type, there was no definite dependent portion in which one might expect a foreign body to remain with the patient in the upright position. The measurements indicated that the coil was confined to the pars media; furthermore all of the films showed that it remained constantly in the same position and the configuration was always the same. It was also evident that the coil must be of a firm nature, since at no time did it change its shape. It appears to be about six to seven inches in length; the fluoroscopic and stereoscopic visualization of the coil is not sufficiently clear to allow of a more exact measurement, due to the patient's stocky build.

Having established the fact that the coil was within the stomach, it remained to be elicited how it got there. The only clue to this was the statement of the patient that he had had an examination by means of a stomach tube some twenty years earlier in a civilian hospital. The connection between this statement and the presence of the coil in the stomach must, of course, remain conjectural. But it is conceivable that the patient at that time retained a portion of the stomach tube, which may have been of a two-piece type, after it had become detached during its passage. It is also conceivable that the tube at once assumed a position in which it could not pass the pylorus. At this point it may be stated that the patient showed no abnormal retention of the gastric contents. In the course of time the coil may have assumed the shape shown in Figure 1, and have become almost petrified, through calcium deposits. The two open ends of the tube are plainly visible. Another

beneath the upper circular opening, would suggest a kinking of the tube at this point. Somewhat more difficult to explain is the constant position of the coil with reference to its distance from the vertebral column. It could not, of course, be adherent to the wall. Efforts to dislodge the coil were made difficult by the fact that the patient's stomach, which was of the hypersthenic type, as mentioned above, was placed high in the abdomen, being almost at the level of the costal arch.

If the patient ever comes to autopsy, there will be revealed a most unusual finding, the precise nature of which must until then remain largely speculative.

AN UNUSUAL FLUOROSCOPIC OBSERVATION

By DANIEL M. MOORE, M.D., Roentgenologist,
St. Francis Sanatorium, MONROE, LA.

A careful review of the subject matter contained in the record of the case reported here has not been made, but the findings seem quite unique and well worth reporting. If anyone has made a similar observation, I would be glad to hear about it.

E. B., colored, age 48, according to the local newspapers, was shot on the evening of April 29, 1932, at the home of his "best friend." He rushed out of the house precipitately, not even taking time to open the gate, preferring to take the fence instead, two panels of which he tore out as he went over. He rushed to his own home about one block away, and the report was that he had to be held in bed until the ambulance arrived to take him to the hospital. He was hastily examined by G. M. Snellings, M.D., with J. G. Snellings, M.D., as consulting surgeon. An X-ray examination was requested. The patient appeared in fairly good condition except for a mild degree of shock, and was able to transfer himself easily from the ambulance cot to the fluoroscopic table.

A cursory examination revealed a puncture wound in the back over the eleventh rib approximately four inches from the spine. Thinking the bullet had probably entered the abdomen we carefully surveyed this part of the body under the fluoroscope, but found no evidence of the bullet or other changes from the normal. The diaphragm appeared smooth and regular and made free respiratory excursions, and no evidence of fluid in the thorax was noted. In the middle of the heart shadow was a density having the appearance of the leaden bullet, and it was doing all kinds of gymnastic stunts, toppling over and over from side to side very much as a ball in a fountain's stream of water, or a leaf in an eddy. This was observed for several moments during which time the patient stated that he was feeling very well; he appeared quite comfortable. We then had him turn on his left side for a few moments. The shadow still occupied the center of the stage ("the center of the stage" in this instance being the heart shadow), but suddenly dropped well down toward the apex of the heart approximately two inches from its original site, and then almost immediately shot upward to the posterior aspect of the base of the heart and lodged in a fixed position. No amount of turning or manipulation appeared to affect this position.

The first impression that we gained was that the bullet was in the blood stream within the heart chambers, but this seemed so utterly impossible or inconsistent in a living man that we abandoned it in favor of the pericardial sac. We assumed that the bullet was in contact with the auricle and was producing an auricular flutter, and when we changed the position of the patient it slipped downward and then upward in the sac and finally lodged in a neutral zone and the heart action quieted down to something like a normal rate. There was no appreciable amount of hemorrhage into the peri-

cardium, fluoroscopically. Surgical removal of the bullet from the pericardium seemed indicated.

An hour later J. G. Snellings, M.D., opened the pericardium with the assistance of Dr. Jay W. Cummings. They found it filled with blood but were not able to locate the bullet, but, instead, found a rather large slit-like opening in the right ventricle which was leaking badly. Attempts to suture this opening were not successful and the man died on the table. I was present at the autopsy performed by C. P. Gray, M.D., Coroner. The bullet (a .38-caliber) was found lodged in the bifurcation of the left pulmonary artery.

SUMMARY

This case is of interest because of the following facts:

(1) A man with a bullet lodged in the chambers of his heart was able to run a city block, after tearing down a fence in his haste, and lived in apparent comfort for two hours.

(2) Three physicians were able to observe the antics of the bullet in the chamber of the heart before it finally lodged in the pulmonary artery.

EPITHELIAL POLYP OF THE LARYNX DEMONSTRATED BY THE ROENTGEN RAY

By W. H. McGEHEE, M.D., *Instructor,*
Department of Radiology, University
of Cincinnati

Considerable interest has been manifest during the last three years in the study of the neck in the lateral projection. Such studies have been stimulated by the original work of Brown and Reineke, in 1928, and later by the excellent monograph of Hayes. Careful review of the literature has failed to reveal any cases of polyp or papilloma of the larynx demonstrated by the roentgen

ray, with the exception of the single case in the Hayes publication. This lack of similar cases in the literature and the age of the patient to be presented, seem sufficient to justify this case report.

R. M. (Case No. R-2968), white male, age five years, entered the Cincinnati General Hospital complaining of loss of voice. The onset of the present illness began with hoarseness ten months before admission. The hoarseness grew progressively worse until the child could not speak above a hoarse whisper. There had been no obstruction to breathing, only occasional choking on swallowing. The past history was irrelevant. General physical examination was essentially negative.

Roentgen study (lateral view of the neck) showed a tumor mass, approximately 0.5 cm. in diameter, arising from the larynx at the level of the fourth cervical vertebra. The laryngeal ventricle was not demonstrated. It was assumed that the tumor was encroaching on the vocal cords. Impression: Polyp of the larynx.

Direct laryngoscopic examination disclosed a growth about the size of a pea, situated in the anterior commissure, hanging



Fig. 1. Roentgenogram made in right lateral projection. There is a small tumor mass arising from the anterior wall of the larynx at the level of the fourth cervical vertebra.

between the vocal cords. The cords were reddened and thickened.

At operation the clinical and roentgen findings were confirmed. The voice was definitely improved when the child was discharged.

EDITORIAL

LEON J. MENVILLE, M.D. *Editor*
BUNDY ALLEN, M.D. *Associate Editor*

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THE CO-OPERATION OF THE LABORATORY WITH THE HOSPITAL TUMOR CLINIC

The treatment of patients with malignant newgrowths and the investigation of the causes of this condition are among the largest and most important tasks confronting medicine to-day. Unfortunately, I can add nothing new to the subject. My part in the program is to describe briefly, in terms of the organization of our own institution, our conception of the manner in which our laboratories co-operate with the newly established tumor clinic, to point out how we can be of assistance to this special group in research, and then to mention briefly a few lines of investigation which might be profitable.

Ours is a general hospital, mainly for acute illnesses, of about 600 beds. We have a large pavilion for children, ward service, and service for private patients. The various specialties are well organized; in addition, there are study groups made up of interested clinicians from the various services, as well as representatives from the laboratory. Several of these special groups, which have an endowment for research, have full-time representatives in the laboratory. These men are members of the laboratory staff, being responsible to the Director of Laboratories and the Research Committee, as well as to their own special study group. This interlocking system, which has been

functioning satisfactorily for several years, is, we believe, producing results.

The problems which appeal to all of us at the hospital are related to clinical medicine. This does not mean that our investigations are those of applied research only. On the contrary, it is our hope that many of the investigations are fundamental in character. They are all investigations, either of the clinical material and of ideas suggested by the clinical work, or else into experimental fields originating from either of the two sources just mentioned. Should we be fortunate enough to accomplish something in experimental investigation, we expect to follow this to a certain limited extent, but not indefinitely. If something worth while is found, the results will be published so that other institutions devoting themselves entirely to pure research may follow if they wish, leaving our group free to return to their problems of the type for which we have special facilities.

Not only do we co-operate with clinicians in the way just described, but we encourage clinicians to come with their ideas to our laboratories to start work, giving them all the facilities and assistance we can. By having many of our clinicians at work on their own investigations, we have made progress which we believe is in the right direction, but we are now close to our limit of space and funds for this important phase of our institutional life.

There is no originality claimed for this organization—undoubtedly it is being carried on in a similar way in many institutions. We do believe that the spirit of co-operation between the laboratory and clinical groups is genuine, and we are really at work hoping to accomplish some of our ambitions.

In an organization such as we have, it was very simple to organize an additional group, the tumor clinic group. Our pathology department was well organized with its own department head, before the inception of the tumor clinic. For years it has been our practice to have all material removed in the operating room examined grossly and microscopically by the pathologist. Diagnoses are returned routinely in from two to three days, and they can be returned in less than 24 hours. In addition, for a number of years, our pathologist has made frozen sections in one of the rooms of the operating suite, giving his diagnosis to the surgeon in from three to five minutes after receiving the specimen. We are willing to make a definite diagnosis in more than 95 per cent of the specimens. When a definite diagnosis has been made from frozen sections, it is practically never necessary to change the diagnosis in any essential way from a later study of the permanent sections. It should not be understood from this that we believe that we are always correct in our frozen section or any other kind of diagnosis. However, it does mean that we have just as much chance of being right or wrong, when we make definite diagnoses from frozen sections as we have from the finished sections. Even in the small percentage of instances in which we cannot make a definite diagnosis, our pathologist's opinion frequently is of help to the surgeon.

We now have another experienced pathologist in the Director of our tumor clinic, who is welcomed by our hospital pathologist in studying the frozen sections, as well as all other material. Thus, we are now able to study to the limit of our facilities not only the histogenesis of tumors and their mode of dissemination, but also characteristics of unusual tumors, the effect of various procedures on tumors, the grading of malignancy, radiosensitivity, and other factors of interest.

Our clinical laboratories have always fol-

lowed blood changes, which, to a certain extent, act as aids to guide special workers in radiotherapy in the amount of radiation to be used, the reaction of the patient, etc. Our chemical laboratory, with its own department head, can furnish a limited number of blood chemical determinations, and the bacteriologic and serologic division, with its separate department head, can furnish co-operation in its special field to a limited extent. The metabolism department may be an important factor in studying malignant disease. Our necropsy department is a definite aid in observing the end-results of neoplasms and furnishes somewhat of a check of the results of therapy, whether this is by surgery, radiation, or other means.

It requires considerable funds to furnish the tumor clinic with all of the laboratory co-operation it should have. Since investigations of this type require many specially trained workers, generous amounts of laboratory space, animal facilities, etc., additional, very sizable funds are needed everywhere for "cancer research." Every tumor clinic should have adequate research facilities, as each one of these special groups undoubtedly has many important problems for investigation and will develop still more with the work of its department.

So many outstanding individuals are at work, trying to solve the problem of the cause or causes of cancer, that it is with considerable reticence that I suggest a few possible fields of study which might be profitable.

More knowledge is needed of the biology of malignant growths, and, to understand this, knowledge must first be established of the biology of normal tissue growth. Carrel, Fisher, and others have made important contributions in this field. The metabolism of malignant tissues must be studied, and here Warburg and others have made important advances.

The effect of general measures, such as sunlight, vitamins, etc., demands study, for,

as emphasized by Yates and others, malignant tissue itself spreads in somewhat the same way as various bacterial infections. (This does not mean that the cause of malignancy is considered to be an infectious organism but merely that the spread of malignant disease along lymphatics and tissue planes is similar to the spread of some infections.) Since selected general measures are of therapeutic value in the management of infections, certain of these should be considered as having value in the treatment of malignant disease.

More investigation is needed of the possibilities of radiotherapy, its accurate control, its limitations, etc. More study is needed of the manner in which radiation, in therapeutic doses, influences deep-seated tumors. Does it produce its effect by direct action on the malignant cells, or indirectly through the non-malignant tissue cells and fluids of the body? There is still a difference of opinion about this.

More investigation is needed of the value of radiotherapy immediately after operations for such conditions as carcinoma of the breast, uterus, ovary, etc. It is my understanding that, at present, there is no clear-cut knowledge of the value of post-operative radiation to prevent recurrences, as, for example, in mammary cancer. The necessity of learning more about the results of such treatment has been brought out recently in a number of articles. Important considerations include: accurate study, by the same experienced pathologist, of breast carcinomas in a large series of patients; the performance of the same type of operation by the same surgeon or a small group of surgeons; the accurate following of the patients after operation, whether roentgenotherapy has been used or not, and the keeping of accurate records of all patients. In order to gain much needed knowledge, it seems to me important that several large series of cases, treated alternately, should be followed. Since there is skepticism among

many of the value of this type of post-operative therapy, a control series of this sort is justified. Only with such a control series will skepticism give way to definite knowledge.

Most important of all must be the attitude that no idea or theory dealing with the possible cause or treatment of malignancy should be discarded because of any *a priori* reasoning. In the midst of our ignorance, every logical idea must be given serious consideration.

Attempts, such as those of Lunsden and others, to build up specific immunity against neoplastic disease, are worthy of trial and experimentation. The search should be continued for a substance with a special affinity for attaching itself to living malignant cells, preferably a substance which will make these cells radiosensitive. A tremendous advance will be made if such a substance can be found. This would increase the directness of our attack on malignant cells with radiation. The chemist might be able to attach to the molecules of such a substance chemical groups which would have a toxic action on malignant cells. Chemical groups staining the malignant cells in a selective manner might be attached to this substance, allowing us to make a diagnosis much earlier than we can at present. Dr. Bloodgood and his group are working in this direction. Fluorescence might be added to the substance with this special affinity for neoplastic cells, which again would allow for earlier diagnosis.

The idea that the real cause of malignant tumors might be an infectious agent should still be borne in mind, for this possibility has not yet been disproved.

If this summary has given you a clear idea of our efforts, it will have accomplished its purpose.

WILLIAM THALHIMER, M.D.

*Michael Reese Hospital
Chicago, Illinois*

COMMUNICATIONS

SYMPOSIUM ON THE X-RAY

This Symposium was a joint program between the Zoölogical, Chemical, and Medical Sections of the American Association for the Advancement of Science, the American Roentgen Ray Society, the Botanical Society of America, the American Society of Bacteriologists, and the Northwestern New York Division of the American Chemical Society. It was one of several symposia held as part of the Summer Meeting of the American Association for the Advancement of Science, June 20-25, 1932. The following papers were presented:

1. "Differential Action of X-rays and its Bearing on Cancer Therapy,"
G. FAILLA, D.Sc., Director Radiological Research, Memorial Hospital, New York City
2. "Effect of X-rays on Germ Cells and Heredity,"
JAMES W. MAVOR, Ph.D., Director, Department of Biology, Union College, Schenectady, N. Y.
3. "The Significance of Proper Physical Measurements in Interpreting the Biological Action of X-rays,"
LAURISTON S. TAYLOR, Bureau of Standards, Washington, D. C.
4. "Clinical Observations on the Relative Value of Radium and X-rays,"
DOUGLAS QUICK, M.D., Memorial Hospital, New York City
5. "Changes Following X-ray Treatment of Newgrowths,"
R. E. HERENDEEN, M.D., Memorial Hospital, New York City
6. "The Quantitative Evaluation of the Effects of X-rays on Cells of Different Sizes,"
R. W. G. WYCKOFF, Ph.D., Rockefeller Institute for Medical Research, New York City

7. "Some Quantum Calculations on the Lethal Effect of X-rays,"
WHEELER P. DAVEY, Ph.D., Professor of Physical Chemistry, Pennsylvania State College
8. "On the Nature of the Action of X-rays on Living Tissues (Blood-forming Cells),"
RAPHAEL ISAACS, M.D., Asst. Director of Thomas Henry Simpson Memorial Institute for Medical Research, Ann Arbor, Mich.
9. "The Death of Yeast Cells by X-rays,"
OTTO RAHN, Ph.D., and M. N. BARNES, Department of Bacteriology, Cornell University, Ithaca, N. Y.
10. "The Chemical Effects Produced by X-rays on Aqueous Solutions,"
HUGO FRICKE, Ph.D., Department of Biophysics, Long Island Biological Association.
11. "Some Physiological and Genetic Effects of Grenz Rays,"
T. H. GOODSPEED, Ph.D., University of California
12. "The Effect of X-rays on Tumors in Animals Treated by the Heublein Method,"
HALSEY J. BAGG, Ph.D., Memorial Hospital, New York

MEDICAL SOCIETY OF THE STATE OF NEW YORK

At the 126th Annual Meeting of the Medical Society of the State of New York, held in Buffalo, N. Y., Tuesday, May 24, 1932, the first Session on Radiology was given. The program was as follows:

1. "The Accessory Nasal Sinuses in Scarlet Fever,"
DONALD S. CHILDS, M.D., Syracuse
2. "Structural Changes of the Aorta Due to Arteriosclerosis as Observed Roentgenologically," Lantern Slide Demonstration.
JOSEPH H. GREEN, M.D., Rochester

3. "The Correlation of Roentgenological Findings and Pathological Specimens of Gastric Cancers and Ulcers with their Differentiation,"

LEWIS G. COLE, M.D., New York City

4. "The X-ray as an Aid in the Early Recognition of Serious Disease of the Colon,"

W. H. STEWART, M.D., and

H. EARL ILLICK, M.D., New York City

5. "Chronic Duodenal Stasis,"

ROSS GOLDEN, M.D., New York City

6. "Scope and Application of Radiation Therapy,"

DOUGLAS QUICK, M.D., New York City

7. "Some X-ray Evidences of Intracranial Pathology,"

CHARLES W. SCHWARTZ, M.D.,
New York City

8. "X-ray Findings in the Diagnosis and Treatment of Pulmonary Tuberculosis" (Lantern Slide Demonstration),

OSWALD R. JONES, M.D.,
New York City

LETTERS TO THE EDITOR

May 10, 1932.

Editor of RADIOLOGY: May I have the use of your column to make the following brief remarks in reference to a statement appearing in "Roentgenologic Exploration of the Mucosa of the Gastro-intestinal Tract," of your February issue (page 230)?

At the time of my publication of "Roentgen Studies of the Mucosa in the Normal and Pathologic State" (*Am. Jour. Roentgenol. and Rad. Ther.*, July, 1923, X, 526-537) the work of Dr. von Elischer was unknown to me. It is true that the methods of examination were very similar; however, the purposes of these investigations were entirely different. Not-

withstanding this fact, I felt that the lack of reference to von Elischer's work was an injustice and, as soon as it came to my attention, I wrote to him apologizing and at the same time acknowledged his priority in the work. It is unfortunate, however, that I cannot substantiate the senior collaborator's statement concerning his early use of the mucosal study. Neither any member of my class at the Army Training School nor I can recall Dr. Cole's method of sedimentation or any reference by him to the diagnosis of gastro-intestinal pathology by study of the mucosa.

Sincerely yours,

RICHARD A. RENDICH, M.D.

116 Remsen Street

Brooklyn, N. Y.

REPLY

May 26, 1932.

In reply to Doctor Rendich's comment, I would state that, for the Army Training School, I used the same curriculum and same group of slides which, as Professor of Radiology of the Cornell Medical School, I had used previously for the instruction of undergraduate students. I have retained the lantern slides which were used for both of these classes, and two of these slides, showing early mucosal technic, are identical with the illustrations in RADIOLOGY. I am sorry that my instruction was so unimpressive.

Sincerely yours,

LEWIS GREGORY COLE, M.D.

36 East 61st Street

New York, N. Y.

NOTE

Readers will note the omission of Abstracts of Current Literature from this issue. This does not indicate a future policy or any lack of material. It is an emergency measure necessary, we hope, this month only.

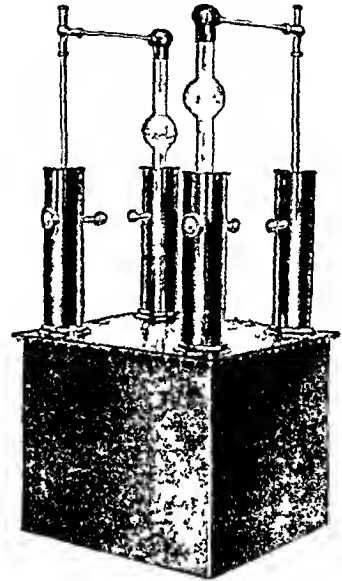
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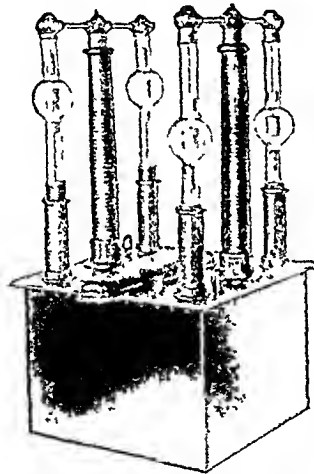
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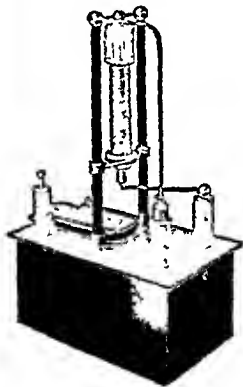
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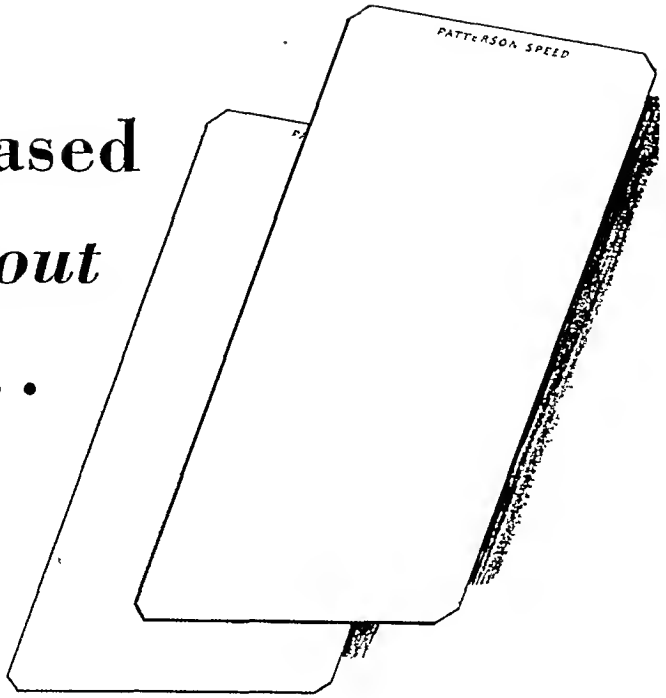
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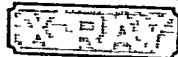
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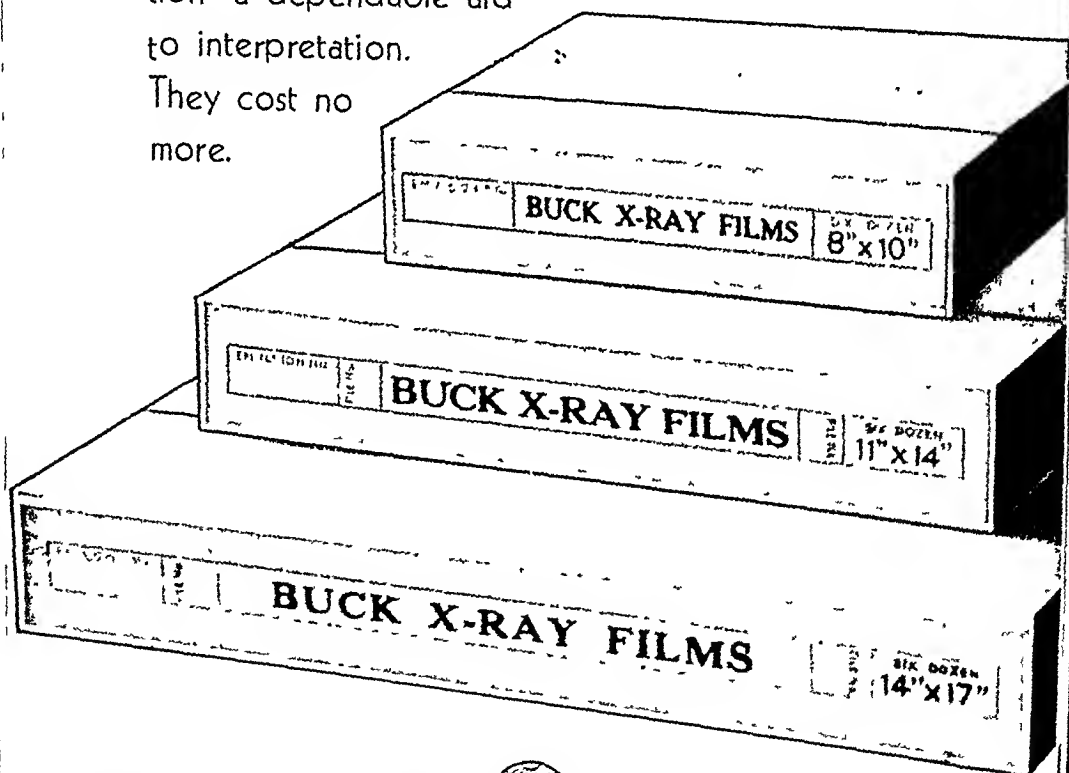


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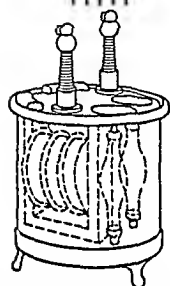


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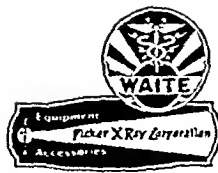
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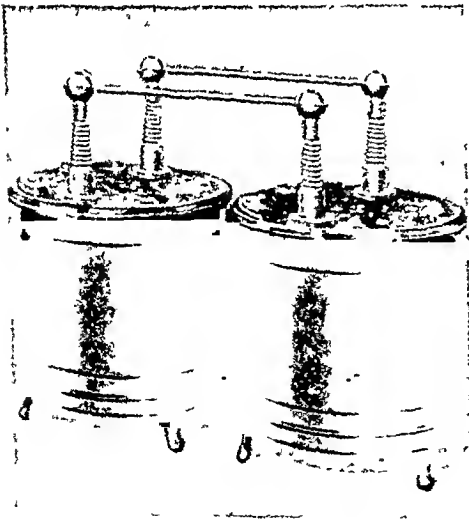
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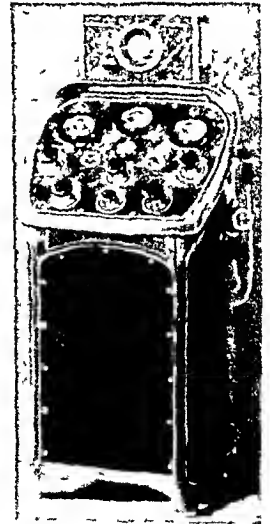
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